THE

ELECTRICAL REVIEW.

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J. A. BERLY'S

UNIVERSAL ELECTRICAL DIRECTORY

For 1893

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SCIENTIFIC SOCIETIES.

THE *Times* of Wednesday week contained a criticism of the Royal Society. The opening remarks expressed the desirability of maintaining the high standard of merit necessary to obtain the bestowal of Fellowships of the Society. Our contemporary then said that this Society was free from the "more vulgar" temptations offered by other Societies which are similar in their purposes. It is constituted upon larger, more dignified, and more independent lines. The number of elections in each year is limited to 15, and an attempt made not long ago to raise the number was fortunately defeated. Since there is no financial necessity for an increase of the membership, it is obvious that nothing could justify it except indisputable evidence that every year produces more than 15 candidates possessing claims of such a kind that their exclusion is a positive injustice to themselves and an injury to the cause of science.

The *Times* correspondent considers 15 elections per annum quite sufficient for the due recognition of really original investigation, and it is only by a loose and wide interpretation of the governing clause in its constitution that the Royal Society can fill up, year by year, the full number of its permitted elections. This we can readily believe, for not half the men elected during recent years have benefited the world by any strikingly original discovery, or, indeed, any discovery whatever. It seems, in these days, that one has only to study science sufficiently to take his B.Sc. and D.Sc. degrees, get elected to a professorial chair in some technical school or university, read a few papers on subjects generally well-worn and oftentimes previously suggested by others, and then wait patiently for the coveted distinction of F.R.S., until he is nominated by friends, who have already gained admission to the charmed circle by the same cycle of operations. But though it escapes, says the *Times*, the vulgar temptations to extension and accompanying degradation of its fellowship, this laxity in construing its aims opens the door to more subtle abuses, which become mischievous in proportion to the greatness of the Royal Society's position and functions.

There are not 15 new men every year who really conquer new fields, and in the proper sense of the words, "improve natural knowledge." Hence some are always elected on the strength of work which is not novel or original, and sometimes is not even sound and accurate. The fact that there is this uncertainty in the standard makes it easy, unless the greatest vigilance is exercised, to pass over real workers who do not pull wires, and to choose an unnecessary number of mere adapters who do. Take Mr. S. A. Varley as an example. He is credited with being joint inventor with Wheatstone and Siemens of the reaction or self-exciting principle of the dynamo, although it is well known, and now generally admitted, that he stands foremost of the trio. He *did* invent

compound winding, and yet, notwithstanding the everlasting benefit to the world of his famous researches, he still remains simply Mr. Varley. Surely not a man elected to the Royal Society of late years has such a record. In this way it becomes an important question whether the actual machinery of the Royal Society secures the best results attainable.

The Council is practically a co-optative body. Nominally 10 members are annually chosen by ballot in a general meeting, 11 of the existing members retaining their seats. But a list of 10 names is always submitted by the existing Council, and everyone with any experience of such matters, knows how very hard it is, except in extreme cases, to offer any effective opposition to the nominees of the governing body.

The ballot sheet just issued by the Institution of Electrical Engineers is a case in point. The names selected will not, as a technical contemporary observes, please everybody; indeed, some will cause displeasure to a considerable number, yet under the present system of election there is little doubt but that the nominees of the Council will have no real opposition, for the number of members who take the trouble to investigate the claims of the candidates put forward form but a small percentage of the whole.

As we said three weeks ago, the idea that there are several distinct classes of members who are not properly represented on the Council seems fallacious, and we are glad to notice that *Electrical Plant* agrees with us on the points to which we directed our comments, and we are quite at one with our contemporary when it says that those members of the Institution who require interests represented, which are not embraced by the science of electrical engineering for the promotion of which, it maintains, the Institution was founded, had better go elsewhere for the advancement of their peculiar interests.

A letter addressed last week to another contemporary points out that some time ago an agitation was started and carried to a successful issue against the neglect of submarine cable and telephone interests in the Council of the Institution of Electrical Engineers. In consequence of that agitation the Council amended its ways, and recommended Sir James Anderson, Sir Henry Mance, Sir Albert Cappel, and Colonel Jackson, to fill the vacancies at the then pending election.

Since then two of these gentlemen have dropped out, and the point to note, says the correspondent, is that, instead of electing other gentlemen from the same professions to fill the places of Sir James Anderson and Sir Albert Cappel, the Council have reverted to their old loves, and have recommended still more electric light representatives.

This, however, seems to us to offer no fresh cause for complaint. Submarine telegraphy and telephony are fairly well represented both scientifically and industrially in the persons of Sir Henry Mance, Mr. W. H. Preece, Colonel Jackson, and Mr. Alexander Siemens, although, perhaps, the election of another representative of cable manufacturing companies might have been advantageous. Even this is doubtful, for a branch of electrical engineering so thoroughly well understood and practised by those engaged in girdling the earth scarcely requires fostering by the Institution in any shape or form, and probably the workers in the above subjects are quite contented to see their interests represented by the gentlemen we have named.

Those who have shown their dissent with the Council of the Institution as at present formed, seem imbued with the idea that each member is only competent to deal with a solitary subject, when a little consideration would lead to the conclusion that several are specialists in most branches of electrical engineering. Mr. Preece does not confine himself merely to telegraphy; he has also probably the largest consulting practice in electric lighting of any man in the kingdom. Mr. Mordey, although now an authority on dynamo machinery, is equally at home in matters telegraphic. Alexander Siemens is an all round man, so is James Swinburne. Sir David Salomons, although he does not use his versatile attainments as a means of livelihood, is well able to advise on nearly every branch of electrical engineering, scientifically or commercially, and as much may be said for others on the Council.

We suggested that more names than those required to fill the vacant places should be offered for members to select from, and this suggestion, which we understand has already been tried and failed, was endorsed by *Electrical Plant*; but it has been argued in another quarter that if six gentlemen are nominated from the Council and only three can be elected, the others must stand out in the cold, a position of an unpalatable nature, and not desired by the majority of people.

Perhaps the simplest way of all would be to leave the names of new members and associates of council blank, and let every voter write down his own nominees; but if the trouble entailed in finding out who had received the greatest number of votes turned out to be too onerous, one must reluctantly confess that the duty of nomination had better be left, unsatisfactory as it now is, in the hands of the Council.

But whether the proceedings of the Institution as confined to papers and discussions would be better managed by the addition of new blood is another thing, but that is not the question which the signatories to the recent circular letter published in our issue of November 11th, raised, although it is the sore point with the electrical press.

In the statutes of the Royal Society there is no mention of permanent officeholders, still less any provision for their appointment. The officials are to be chosen annually by the Society out of the newly constituted Council. But the outgoing Council nominates these office bearers as it nominates the ten new members of the succeeding Council, and, as a matter of fact, they become permanent. They are five in number, which is a very large proportion of the Council; they naturally tend to cohere more and more closely the longer they work together, and to oppose a more and more stubborn resistance to outside interference, not of malice aforethought, but simply by the nature of the case. Experience again indicates that within the Council it must be very difficult to make any successful resistance to the officials. They are sure to have some steady supporters in a body they have a large share in nominating, and upon any average attendance they are pretty certain of a majority. Finally, it generally happens that in an oligarchy of this kind there is some one ambitious of running the machine, and blessed with leisure to indulge his taste, whose personal preferences and idiosyncrasies leave an unmistakable mark upon the management of the Society.

Galvanometer Control.

MR. WILLYOUNG describes in our American contemporary, the *Electrical Engineer*, a ballistic galvanometer which includes a new and ingenious method of varying the control without the inconveniences of altering the earth's field. The system consists of four bell magnets, two being at centre of coil, and two at the periphery; the latter have their poles turned the opposite way to the former, and are the stronger, so that they normally control the system. One of the larger magnets (the lower one) has a fine screw thread on it, and on this runs a small ring of soft iron. By screwing this up the lines of force of the lower magnet are short-circuited, more or less, and the control of the outer magnets made less and less. Since the inner magnets do nearly all the deflecting work little sensibility is lost. By this means periodic times as long as 40 seconds have been obtained with no perceptible drift. The great objection to the method is the necessity of unhooking the whole system each time the sensibility has to be varied.

Condensers in Alternate Current Supply.

IT is well known that the self-induction in a circuit can be neutralised to a large extent by the use of condensers to supply the proper component of the current. M. Korda has recently pointed out that a similar result can be obtained by placing a condenser in the secondary of a transformer whose primary is part of the circuit to be compensated. The advantage of this is the ability of using a much smaller capacity, in which the dielectric may be a liquid, thus giving power of adjustment and safety from breakdowns. The compensation is necessarily only approximate, as the currents are not perfectly sinusoidal, and the self-induction is not all used in the transformer, although by making this a considerable part of the whole, a certain amount of compensation is possible.

Armature Reactions.

PROF. H. J. RYAN has recently published a few preliminary tests made with a dynamo balanced for armature reactions. This was accomplished by running conductors inside the polar faces which carry the armature current, and are so proportioned as to have the same magnetising effect, but in the opposite direction. The result has been very satisfactory, as with a machine made with an excessively small air gap, due to having a Pacinotti drum armature overspun with iron wire, there were no armature reactions, the neutral point being unshifted and the magnetic density the same in the air gap both at no load and full load. It is probable that in this or some similar manner the weight efficiency of a given machine may be largely increased.

Why Acids are Strong or Weak.

FROM an examination of the electrolytic conductivity of various bi-basic acids at different dilutions, W. Ostwald has recently deduced the conclusion that in some cases the first replaceable hydrogen atom is split off as an ion almost entirely, before the second hydrogen atom begins to be attacked. In other cases the second replaceable hydrogen atom begins to come off when only about 50 per cent. of the first is dissociated. In a paper which may be consulted in the *Zeit. Physikal. Chem.*, ix., pp. 553—562, Ostwald considers the phenomenon in connection with the behaviour of different polybasic acids with respect to indicators, pointing out that many feeble acids may be sharply titrated, while much stronger acids give no sharp "end point." The explanation given is as follows: A bibasic acid, $R'' H_2$, dissociates first into $\overset{+}{H}$ and $R'' \overset{-}{H}$, which latter in its turn dissociates into $\overset{+}{H}$ and $\overline{\overline{R''}}$. Since the radicle $R'' H$ is already charged with one unit of negative electricity, which is associated with the atom to which the positive ion of the undissociated compound was attached, there will be more or less difficulty in effecting the introduction of a second negative charge into this radicle, according as this second charge is nearer or further from the first charge. Consequently, the nearer the charges of the bivalent ion, $\overline{\overline{R''}}$, are to each other, the less will be the tendency of the second hydrogen atom to dissociate. But when two replaceable hydrogen atoms are near each other in the molecule, the acid is, *cæteris paribus*, a strong one, and when they are far removed from each other, it is a feeble one; so that there may often be a reluctance on the part of a moderately strong acid to dissociate a second hydrogen atom.

Permanently Magnetised Cores in Telephones.

WE recently gave some account of Dr. Trouton's views on the theory of the use of a permanently magnetised core in the telephone. Although his explanation is undoubtedly true there seems to be a second side to the question which he has wholly left alone; at least, this is the expressed opinion of Mr. J. W. Giltay, writing from Delft to the *Philosophical Magazine*. According to his investigations the permanent magnet in the telephone plays two *rôles*, each quite different from the other, viz.:—1. It serves to give the sounds the required loudness. 2. It serves to give the sounds the true pitch. He states that his researches have demonstrated to him that when a non-polarised telephone is joined to the secondary of an induction coil in the primary of which a microphone is placed, the sounds given out by the telephone are an octave higher than those produced before the microphone. Of course it follows from this that such a telephone will be unable to speak intelligibly, as all the vowels lose their character by this change of pitch. [The vowel E thus becomes A, pronounced as in Dutch or in French, but the other vowels are quite lost.] Mr. Giltay admits that "the experimental proof of this fact is very difficult, owing to the inevitable *remanent* magnetism of every iron core, and also to the feebleness of the sounds given by a non-polarised telephone;" but it is very easily proved when a speaking condenser is used instead of a telephone. His own experiments on this subject are described in two papers published in the *Archives Néerlandaises* t. xix. (1884) and t. xx. (1885), entitled respectively "La Polarisation des Récepteurs Téléphoniques," and "L'Emploi de la Pile auxiliaire dans la Téléphonie."

French Energy in the Gutta Industry.

IN the French possessions in the Indies, especially in the neighbourhood of Saïgon, great efforts are now being put forth in the cultivation of gutta-percha yielding plants, which are sanguinely expected to be shortly very successful. Mons. Sérullas, who has made a systematic study of the gutta tree and the best methods of cultivating it, and has experience extending over several years, hopes also to grow this valuable tree in other parts. He brought with him from his last expedition some hundreds of specimens with which to experiment in Algiers and in Guiana. The scientist claims that he and Mons. Jungfleische have really discovered a method of extracting the gutta without involving the destruction of the trees. In their communication to the Société d'encouragement pour l'Industrie Nationale they state that the leaves contain more of the precious gum than do the trunk and branches, and that it can be extracted by a purely chemical process without waste. The dried leaves are soaked in toluene, and from the resultant solution the solvent is removed by treatment with steam, leaving the pure gutta behind. English cable manufacturers have always been sceptical as to the quality and durability of chemically extracted rubber, hence they may probably regard this process with no more favour than they will the following:—The leaves and twigs are pounded and soaked in carbon bisulphide; the solvent is evaporated off in a boiler and is condensed for future use, leaving the gum in the crude but pure state. This is the invention of Mons. D. Rigole, who has elaborated an apparatus in which all the heating is done by steam.

NOTES UPON THE USE OF THE D'ARSONVAL GALVANOMETER ON SHIPBOARD.

BY H. W. SULLIVAN, M.INST.E.E.

WHILST electrical apparatus generally has undergone so many improvements since the early days of submarine telegraphy, time has evolved but two modifications of any importance in the one galvanometer of precision available for use on board ship, viz., winding the coils to 30,000$^{\omega}$, and the exceedingly useful damping arrangement of air chambers. The fact would appear to demonstrate the practical convenience of "Thomson's marine." Nevertheless this form of galvanometer possesses fundamental objections in that—

1. It is not aperiodic or dead-beat. This is often a serious inconvenience, *e.g.*, when observations have to be made during the rapid changes of potential, so frequent in fault testing.

2. Balancing the mirror is at all times a very delicate and tedious matter. None of the text-books give any description of how this indispensable operation is carried out, and, as is well known, not one electrician or mechanician out of 10 can accomplish it so thoroughly that the "spot" does not move at all, as the vessel rolls and pitches.

3. The balance gradually becomes disturbed through thermal and atmospheric changes.

4. The zero point of the instrument shifts with alterations in the ship's direction.

5. The fibres are very delicate, and subject to torsional error.

6. The magnets at the back of the mirror may be demagnetised through inadvertence.

7. The whole instrument is very cumbrous.

A consideration of the galvanometer, known generally as the Deprez-D'Arsonval, but which is identical in principle with Thomson's siphon recorder, will manifest its freedom from all the objections enumerated above, save 2 and 3.

On the other hand, the greater weight of the coil must of necessity cause the suspension to "sag" or curve slightly from side to side, or end to end, as according to the motion of the ship, but a simple means of surmounting this difficulty, as also objections 2 and 3 suggests itself, and will be referred to presently.

The D'Arsonval galvanometer (ordinary form) was lately used with entire success in certain tests, as applied during the laying of an important cable, and this being the first occasion of the kind, a few notes upon the subject may not be uninteresting to the readers of the ELECTRICAL REVIEW.

The writer may say that the instrument in point was quite sensitive enough for C.R. measurements, although not so for dielectric resistance observations of ordinary lengths of cable. Before embarkation, the coil system was balanced in the usual way to any angle of lift or tilt. Owing to its absolute dead-beatness, nothing could be more satisfactory than the working of the instrument in all weathers, not only for C.R. measurements, but in observations by the first swing of the mirror, *i.e.*, capacity determinations of short lengths of cable by the direct charge method—such a difficult matter with the marine galvanometer, even when damped, as all can testify who have ever attempted it. No trouble was experienced from the effect of "sag." Prof. Ayrton has pointed out that with the ordinary D'Arsonval the deflections are not strictly proportional to the strength of the current, owing to the torsional effect exerted by the lower suspension.

The scale not being calibrated, error from this source was eliminated in the case of the capacity tests above mentioned, by an adjustment of shunts to produce the same throw from cable and condenser.

Referring, now, to objections (2) and (3), &c. The necessity for exactly balancing the coil, together with all error due to "sag," might be obviated, were the instrument mounted on a gimballed table, so as to keep it in the horizontal plane in any position of the ship. It seems reasonable to suppose that, except at times of very violent motion (when no cable work could be done), the instrument if thus swung, would respond rapidly enough to the movements of the ship, to remain practically in stable equilibrium. If so, the coil might be suspended freely from the top, the current being led out from the bottom by a fine wire spiral, as recommended by Prof. Ayrton, to obtain greater sensitiveness and proportionality of current and deflection. At the least, the experiment may be usefully tried when the opportunity offers. In any case the advantages of the instrument for C.R. tests by the ordinary null method are obvious. The writer feels certain that any sea-going electrician who has once used a good D'Arsonval galvanometer for such a purpose will never abandon it in favour of the time-honoured "marine."

By resting the entire instrument on a soft India-rubber bed, mechanical vibrations from the ship's engines would be absorbed.

Besides its freedom from the numerous objections common to the marine galvanometer, the D'Arsonval is much simpler in its construction, and has the recommendation of being considerably cheaper than that instrument.

As already stated, the particular D'Arsonval at disposal was one of the ordinary form, and gave too low a constant for dielectric resistance observations, but those of the recent Ayrton-Mather type, with circular pole pieces and narrow coreless coil, wound to a comparatively high resistance, are said to be far more sensitive than any existing marine galvanometer, and to have great dead-beatness on open circuit.

STORAGE BATTERIES IN CENTRAL STATIONS.

THE correspondence and editorial comments in the *Electrical Engineer*, of New York, on the use of accumulators in central stations, appears to show that the question is misunderstood by a large section of American engineers. A variety of opinions is expressed with reference to the durability of the storage battery, and also to the difficulties of supervising it; and but little credence is given to the reports from European central station men. It is surely time that the advantages, if not the necessity, of storage for public lighting should be more generally recognised. Electric energy should be generated and stored on the lines of gas production, so that it is produced at a steady rate continuously, and stored ready for use at rates bearing no necessarily defined ratio to the rate of production. Electric light stations without storage are compelled to generate power at the same rate as it is used, and hence a high peak in the load diagram necessitates not only an excessive outlay in plant, but must also bring with it at the full load period a feeling of anxiety to the minds of the responsible staff; in fact, probably few of the engineers in charge of such central stations can accept an invitation to dinner with a light heart.

But a storage system obviates all this uncertainty, and with the improved Plantè type cells now manufactured there is no danger of excessive depreciation if ordinary precautions are adopted. Indeed the great secret of success with accumulators lies in attention to small details which were often neglected in past practice. Such seemingly trivial things as pure acid and also pure water are now recognised as of the utmost importance, and the apparently inexplicable difference in the behaviour of similar cells can frequently be explained by such trifles. It is now being more generally appreciated that the Plantè plate, unlike the pasted grid, can be practically short-circuited without any real injury, and that therefore cells built up with these plates are of the greatest importance in cases of temporary break-downs or overloading, and can be trusted to give a current far in excess of their rated output.

The function of a storage battery in a central station is really threefold, and although it may not always be utilised to its full capacity, yet in most well designed stations the importance of each of its uses is fully recognised. Firstly, the battery forms a reserve against accidents to machinery, and enables temporary repairs to be made without shutting down the whole or a part of the light; secondly, the battery may be used very advantageously for assisting the dynamos to supply exceptionally heavy loads, of a more or less temporary character; and thirdly, the battery will run the lamps direct during the light load periods from, say, about 11 p.m. to possibly 3 p.m. on the following afternoon. In such a case

the accumulators will be charged during two periods of the day. The first from when the engines are started, say at 3 p.m., till that point where the load exceeds the output of the dynamos. The cells are then discharged for a short period until the descending load curve cuts that point where the steam plant can deal with the output, then the charging will recommence and steadily increase in rate as the lamp load is lessened.

It is, of course, necessary to arrange the periods of charge and discharge to keep the cells in good working order; and it will also be imperative to vary the number of cells in series in order to secure a proper result. But these are simply matters of detail, thoroughly understood by the majority of station men.

We think the accumulator is likely to prove of greater importance in lighting work than is anticipated by even many of the present low tension supply companies; and it seems by no means improbable that the future practice for city and town lighting will be a direct current supply with a three-wire system, and storage batteries used in the manner already mentioned.

DEATH FROM ELECTRICITY.*

By H. A. CLOWES, M.D., M.S. DURH., &c.

DEATHS from electricity have happily been of rare occurrence in this country. So far as I am aware, only five cases have been reported in the medical journals since 1880, though many cases have occurred in America and several on the Continent.

On the afternoon of November 9th, T. P. L.——, aged twenty-three, an *employé* of the House-to-House Electric Supply Company, was engaged in making connection with a house in Roland Gardens, Old Brompton Road, and while working in the surface-box he was observed to fall to one side as if in a fit. A fellow-workman ran to him, and found him with his left arm contracted and attached by his left hand to the connecting wire. The wire was immediately broken by a blow with an axe-handle, and when released he gave a loud sigh and fell forward on to his forehead, but made no further movement or sound. He was brought in a cab to the Queen's Jubilee Hospital, where I saw him about five minutes after the occurrence. The heart and respiration had then stopped. The face, neck and upper extremities were congested, the eyes suffused, and the pupils widely dilated. The features were not distorted and the face wore a peaceful expression. There was a strong smell of burning, not unlike the smell of gas, and it was at first reported that the man had fallen down while working on a gas main. The palm and first two fingers of the left hand were burnt and charred, and the fingers were strongly flexed. The clothing was not burnt or injured in any way. Artificial respiration was at once commenced, and was maintained for more than an hour, but the patient did not respond in any way, and it was evident that the case was hopeless. Besides artificial respiration an injection of strychnia was given, with the idea of stimulating the respiratory centre, and the faradaic current was applied to the precordia.

At the inquest which was held on November 14th, the current which the man received was said to have been a rapidly alternating one (10,000 alternations per minute) of a strength of about 2,000 volts. It was not clearly shown how he had completed the circuit, for at the time of the accident he was holding only one wire with the left hand, which was burnt, but there was no other burn an any part of the body. The piece of wire which he held had in some way become denuded of the insulating rubber. A post-mortem examination was made 3 days and 16 hours after death. The body was that of a well-developed, muscular young man, and the congestion of the face, neck, and upper extremities, and ocular conjunctiva, remarked at the time of death, was still noticeable. Rigor mortis, which had set in shortly after death and had been strongly marked, was still present to a slight extent in the lower extremities. Decomposition was not advanced in any unusual degree. The whole of the palmar surface of the forefinger and middle finger of the left hand was burnt, and the tissues of the carpal half of these two fingers were destroyed and carbonised, exposing the flexor tendons. The epidermis generally of the palm of the hand, the palmar surface of the thumb, and of the cleft between the thumb and index finger was burnt black and separated from the deeper structures of the skin. On the dorsal surface of the hand, between the thumb and index finger, the epidermis was destroyed and missing over a surface the size of a florin. There was a small circular abrasion, not a burn, on the outer side of the right knee, and a small ecchymosis and swelling over the right frontal eminence. There were no other external marks of injury. The vessels of the scalp, meninges of the brain, and brain substance, were congested and full of liquid blood, and the surface of the white substances when cut across presented a punctate appearance. The lateral sinuses were full of liquid blood, and the lateral ventricles contained a fair amount of cerebro-spinal fluid. The brain and cerebellum appeared quite healthy. The mucous surface of the larynx, trachea and bronchi was much congested and the lungs loaded with dark blood. The heart was normal in size and consistence, and its valves healthy. Although not contracted its cavities were completely empty, and there was a deficiency of blood in the large vessels. The liver was much congested and of a dark-red colour. The spleen was large and engorged with blood. The kidneys were large (especially the left), congested, and the condition of the tissues doubtful; the stomach and intestines were normal in appearance; the bladder contained about eight ounces of highly albuminous urine. A marked feature of the examination was the complete fluidity and dark colour of the blood, not a clot being discovered in any part of the body. My colleague, Dr. Thudichum, who kindly made a microscopic examination of the blood and nerve tissues, supplies the following note: "Blood quite fluid, without any coagula, and remains fluid on being kept; medulla oblongata and amido-myelin coagulated; no other structural change." He adds: "Electrical current derived from wire to earth, 10,000 alternations per minute, causing 20,000 shocks of contraction per minute, practically tetanus."

* *Lancet.*

ELECTRIC STATIONS AS INSURANCE RISKS.*

MR. GEO. P. LOW, electrical inspector for the Pacific Insurance Union, has sent out a copy of the following letter to each electric lighting and railway station within the jurisdiction of that association. The letter will explain itself.

"I have been asked to prepare a paper on 'Electric Stations as Insurance Risks' for the coming annual meeting of the Fire Underwriters' Association of the Pacific, and inasmuch as you are most certainly interested in securing a proper understanding by fire underwriters of the central station as a fire risk, I take the liberty of asking your assistance in the preparation of the paper named.

"You must be aware that the belief is growing among fire underwriters that electric light stations as a class are very undesirable risks; and I think you will concur with me in the opinion that this belief is not as it should be. To refute it, and to prove such assertions as will be made, by carefully gathered and reliable statistics, will be the aim of the paper, the success of which will entirely depend upon the individual efforts of each company in answering fully and honestly each question asked. Of course, all correspondence will be strictly confidential and in no instance will the name of any company be mentioned, nor will a reference to any particular concern be made. Only aggregate results will be quoted.

"What is desired is the detailed information which will be derived from your replies to the questions asked in the accompanying slip. If the conviction is to be carried that the properly constructed central station should not be classed as a hazardous risk, and if the benefits resulting from such a conviction are to be enjoyed, then you, and you personally, must assist me in the task I have undertaken. As an electrician and one most deeply interested in everything that

* New York *Electrical World.*

will contribute to the advancement of electricity, I urge you to appreciate the importance to this effort to be made on behalf of electrical interests, and to reply fully to each question asked, using a separate slip for each year during which your station has been operated. I am sure this will afford an array of statistics that will prove conclusive."

The questions asked are as follows :

What is the valuation (cost) of your station building, inclusive of real estate ?

What is the valuation (cost) of all dynamos and electrical equipments contained therein ?

What is the valuation (cost) of the boilers, engines, and all machinery, other than electrical, contained therein ?

In what year was the station erected ?

Is the building of stone, brick, frame, or corrugated iron ?

What power do you use : steam or water, or both ?

Is your power plant used for your station exclusively, or does it furnish power to some adjoining industry ?

Or do you obtain power from an adjoining industry ?

What is the nature of such adjoining industry ?

What is your nearest or greatest exposure ?

Is the plant contained in a building occupied by other industries, and what ?

What is the amount of insurance carried for the year above named ?

What did this insurance cost in premiums ?

What gross losses by fire, if any, was sustained during the year named ?

What insurance have you received on these losses ?

Of above losses, what insurance loss, if any, was sustained by fires caused by electricity ?

What insurance loss, if any, was sustained by fire from causes other than electricity ?

What insurance loss was occasioned on dynamos alone ?

What caused the fire in your station ?

What is the character of your station : is it a light and power, or railway generating plant, or both ?

Do you use the alternating or direct current system of incandescent lighting, or both ?

Do you furnish arc lights ?

What is the population of your city for the year above named ?

Was your city in a healthy or unhealthy commercial condition during the year named ?

Did it have a boom ?

ELECTRIC METER COMPETITION.

THE following interesting correspondence appears in *L'Industrie Electrique*, with regard to the electrical meter competition :—

"Monsieur E. Hospitalier,

"My attention has just been called to an article in *L'Industrie Electrique*, for August 10th, 1892, directed at myself and signed, 'E. H.' I will take the liberty to correct some inaccuracies in it.

"In the first place I wish to state that I have never endeavoured to create a confusion between M. Gaston Roux and myself. I have only to ask you to be so kind as to refer to my article of April 22nd, and you will see that I have taken care to put the initials P. G. (Paul Georges) before my name, so as to prevent any error. As to the mistake or confusion made by the *Journal des usines à gaz* ; I was quite ignorant that it had occurred, and knew nothing about the article until I had seen yours of August 10th.

"If any confusion has arisen, it is in no way due to myself, although you try to show the contrary. You assert that in my communication, I thought fit to attack rather fiercely the decisions of the Meter Committee before the Society of Civil Engineers, and that none of the members of this committee took any notice. If you will kindly refer again to my communication, you will have great difficulty in finding any attack, either direct or indirect, on the work of the Meter Committee, whose report we have yet to receive, and which I shall be very glad to see.

"My remarks were directed at the meters only, or more correctly speaking, at the apparatus. Therefore, it is not surprising that the committee took no notice of them. Can you, for instance, deny what I said with regard to 'the 'Aron and Thomson' meters ? I should be very glad of an answer to this question, and should be happy to place before you the opinions and results of experiments of those most able to give an opinion on the subject. Unless you retract what you have said and published in one of the numbers of *La Nature*, I think you cannot deny the capital defect of the Aron meter. Can you tell me of any central station, employing Aron meters (of Berlin) which are provided with the famous cord to which the success of the Aron meter may be attributed. For my part I have had occasion to inspect more than 600 of these instruments, and have never seen a single cord. Strange ! I need not dwell upon the reproach you bring against me of being an 'interested representative ;' I should be very sorry if it were otherwise, so I think we may agree upon that point.

"But I must call your attention to another inaccuracy, which is really unpardonable, and which shows that you criticise articles without having properly read them.

"You insinuate that the object of my paper read to the Society of Civil Engineers was to set aside the decision of the Meter Committee and then bring forward a meter to which the committee had not awarded a prize. Now, the Brillié meter, of which I spoke, had not seen daylight when the committee was occupied with electrical energy meters. In other words, the Brillié meter, which I described to my colleagues, was not presented to the committee. This inaccuracy is the more to be regretted, seeing that you are not ignorant of these facts. The meters submitted to the approval of the committee were sent in December, 1890, and the Brillié patent, of which I spoke to the Society of Civil Engineers, was taken out June 12th, 1891, and the first meter of this new type was not brought out until October, 1891. I ask you to insert this letter, thus granting me the right of reply, and also to be kind enough to answer the facts advanced in it. I think it will be difficult for you to criticise the Brillié meter, which you have never tested, and which you would no doubt refuse to test, preferring to devote your attention to foreign inventions.

"Yours, &c.,

GEORGE P. ROUX."

Reply to M. G. P. Roux :—

"1. We have never accused M. G. P. Roux of creating or endeavouring to create a confusion between himself and M. Gaston Roux. Our remarks were directed at the *Journal des usines à gaz*, which, by the way, has not inserted a word of reply to our note of August 10th.

"2. A copy of the number for August 10th was sent by us to M. G. P. Roux, addressed to the firm which he represents, and we are very much surprised that this copy should not have reached him before.

"3. We have nothing to do with the non-publication of the report of the meter committee, which was drawn up about a year ago.

"4. It is not for us to discuss with M. G. P. Roux, the interested representative of the Brillié meters, the decisions of the committee, these decisions having been, we repeat, arrived at unanimously.

"5. It is no matter to us whether the Aron meters used for industrial purposes are or are not provided with the cord connecting the two pendulums. The meter sent in for the competition had one, and this was the one to which the committee awarded the prize.

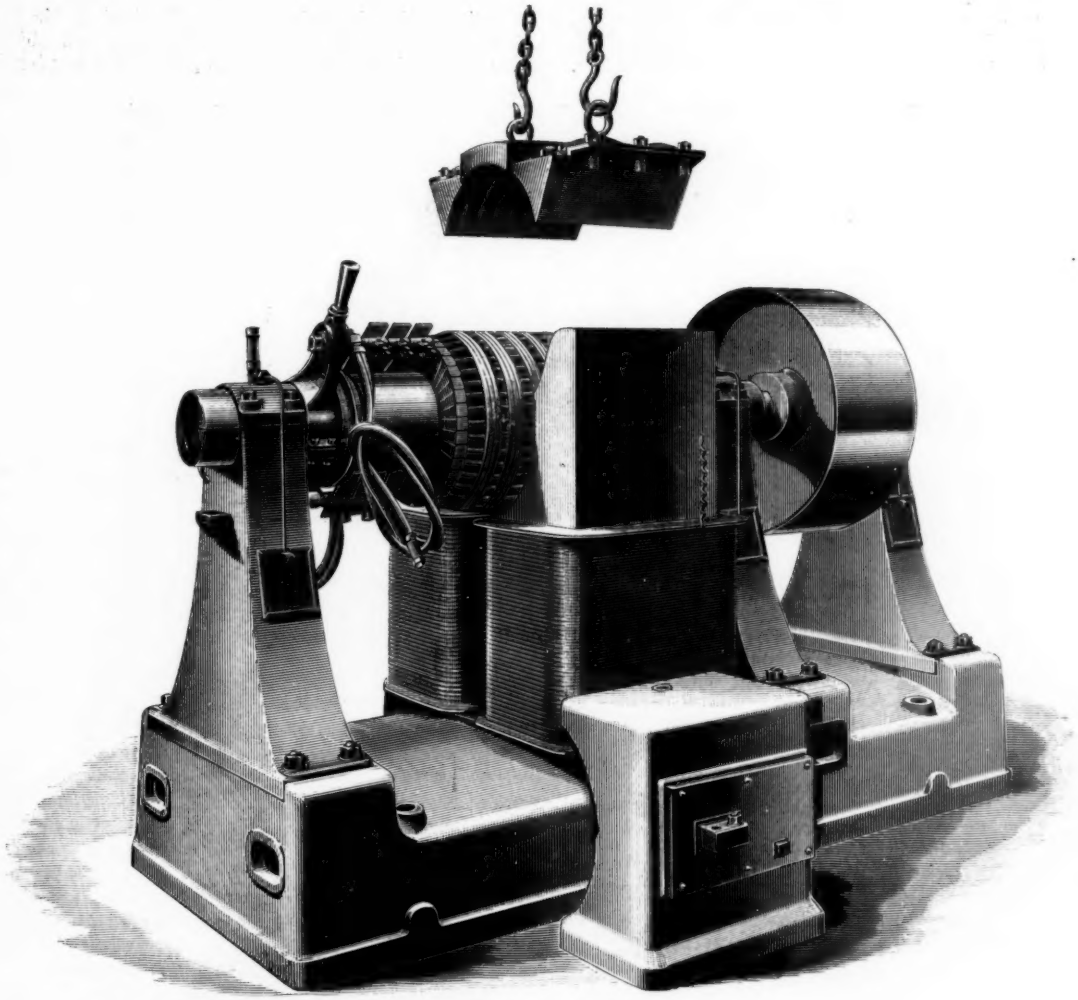
"6. By referring to the text of the paper sent by M. G. P. Roux to the Society of Civil Engineers, our readers will be able to see whether or not the remarks in it are directed against the meter committee.

"7. Lastly, the Brillié meter never having been submitted to us for examination, we have had no occasion to express any opinion as to its value. When an apparatus is sent in to an International competition, it seems to us that what we want to consider is not whence it comes, but what it is worth, even if we have to offend M. G. P. Roux's interested patriotism. The Brillié meter is not then a foreign invention in England ?

"E. H."

IMPROVEMENTS IN DYNAMO MACHINES.

THE Elwell-Parker machines which have been supplied by the Electric Construction Corporation for the South Staffordshire Tramways, and the lighting of Manchester, are of the most improved type. One of the most notable improvements, shown in our illustration, is one which permits the armature to be of easy access. It has been always found in practice that there was much difficulty in threading armatures, especially large ones, through the magnets. To obtain a proper examination necessitated, in fact, the removal of the armature or the bearings; this was always a more or less troublesome duty, because extreme care was necessary to secure a proper readjustment, and there was considerable risk of the parts getting dirty. It will be seen from our illustration how this difficulty has been obviated in a simple manner by Mr. Parker, of the Electric Construction Corporation.



FESTIVE OPENING OF THE ELECTRIC WORKS AT CURITZBA.

[FROM OUR OWN CORRESPONDENT.]

THE day of the 400th anniversary of the discovery of America, which was to have been kept as a public holiday at Curitzba (Province of Parana, in Brazil) but was spoiled by the rain, has experienced an especial consecration by the electric light being set in action.

As far back as the beginning of 1890, the Municipal Chamber resolved on introducing a change for the better in the former miserable, and, at the same time, expensive, lighting of the streets. For this purpose an agreement was concluded with the "Water and Light Company" (*Sociedade Aqua e Luz*). According to contract, the electric installation should have been completed in February, 1892. But when the head engineer, Leopold Stark, and the chief fitter, Andreas Seel, both native Hungarians, arrived in order to complete the structure and the leads, it was quickly found that the locality which the municipality had assigned for the purpose, was very unsuitable. There had to be laid down 20 "brassen" of broken stones, 35 casks of cement and 10,000 blocks of stone as a foundation. The installation was completed only after many unexpected difficulties had been overcome.

The central station for lighting the city lies on a plot of land behind the Congress Hall, and consists of two parts, one containing the appliances for generating the current with their motors, whilst the other receives the steam boilers.

The current is produced by alternating current machines, built by Ganz & Co., of Budapest. There are two machines, one to form a reserve. Five smaller continuous current machines by the same firm supply the current for magnetising the alternating current machines. Only one steam engine has been at present erected, as the other has been lying, since March last year, in the unfathomable depths of a pontoon in the harbour of Santos. The same fate happened also to the reserve boiler, so that at present only one boiler is to be seen.

In the machine room attention is drawn to a large switchboard, where the apparatus for switching, measuring and regulating is fixed. Any of the machines can be con-

nected with the leads to the city, whilst they admit of an exact measuring and regulation of the current. Two automatic regulators keep the tension of the current regular when the number of lamps varies.

In the boiler house there is fixed, on one of the side walls, an injector, which feeds the boiler.

Alongside the building there is an iron chimney, 25 metres high, a well 8 metres deep, and a water reservoir of masonry of the capacity of 12 cubic metres.

The leads are supported on more than 500 wooden posts, and consist of about 65,000 metres of copper wire, of 3 to 8 millimetres in diameter. The system is protected against lightning by 16 appliances enclosed in boxes at suitable points of the city.

The transformers are enclosed in round sheet-metal houses, which are applied on pillars by means of iron brackets. At present eight secondary stations are formed in this manner.

Their number and capability will be increased, according to the number of the lamps.

On Wednesday, the 12th of last month, the engineer, Stark, had invited the "governador," the municipal representatives, and other official personages at 7.30 p.m. He courteously explained to the assembled guests the nature of the machines and the production of electricity.

The Prefect of the Municipality, Dr. Candido de Abreu, then declared the inauguration complete. He congratulated the engineers and the fitter on the able execution of the installation.

The engineer, Stark, then invited those present to the customary "copo de aqua" (literally "cup of water," consisting of a libation of champagne).

CONTINUOUS TO ALTERNATING CURRENT TRANSFORMER.

THIS interesting invention (illustrated below) of Sir David Salomons and Mr. L. Pyke has for its design and object to change a continuous current of 100 volts and 10 ampéres into an alternating current having an E.M.F. of 100 volts and 1 ampére and an alternation rapidity of 1,000,000 per minute. This is ingeniously effected by means of a motor-driven alternator. Hitherto, nothing has been accomplished within a tithe of 1,000,000 alternations. The diameter of the machine does not exceed 1 foot for the rotating portion, and as more than 10 poles to the inch could not well be obtained, the requisite alternation frequency is arrived at without an

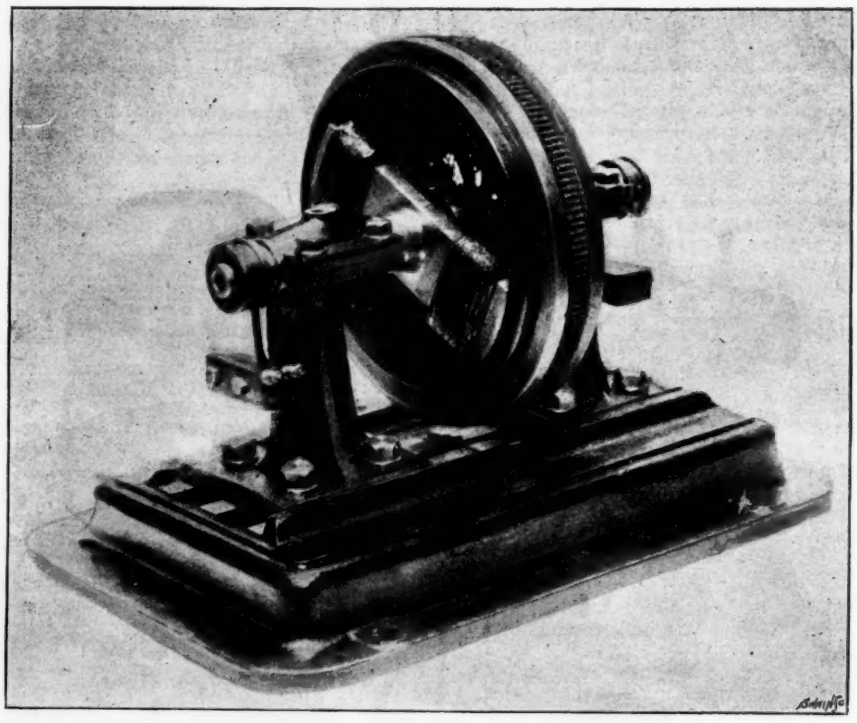


FIG. 1.

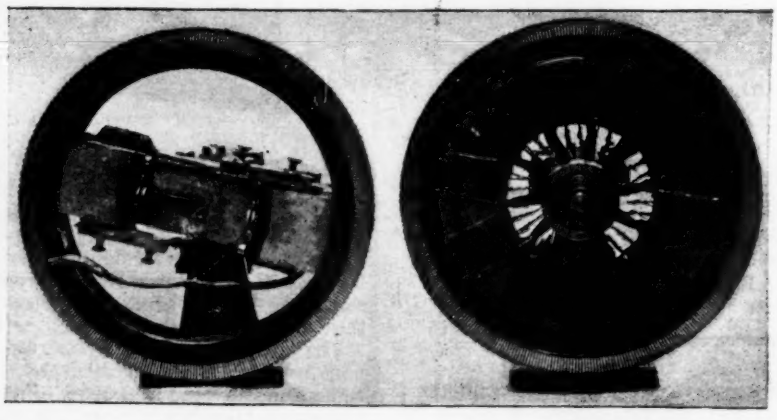


FIG. 2. FIG. 3.

excessive speed by a simple and highly effective plan, viz., by rotating the field and armature of the motor in opposite directions, the brushes of the commutator proper being carried by the field, as shown in fig. 2.

The reactionary effect on the field is necessarily as great as the tendency of the alternator to turn, their speeds being equal, thus 3,000 revolutions is equally divided between the two bearings.

The primary current is taken to, and the alternating current is brought away from, the rotating portion by carefully insulated wires passing through the spindles which are hollow, being connected to their respective terminals by the device of rings and springs.

As the whole of the weight is overhung, it is absolutely necessary that the bearings are true, and as the diameter of the polar faces is very small, necessitating very small air space, white metal thrust bearings are employed.

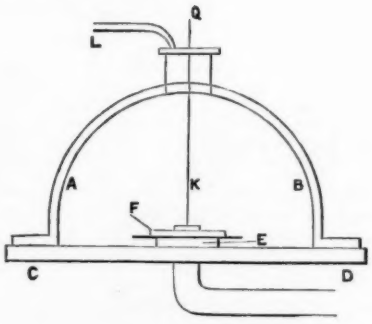
This apparatus will be of great value for the quantitative investigation of phenomena, as yet but crudely explained by means of inappreciable currents.

Sir David Salomons exhibited the alternator at the Institution of Electrical Engineers last Thursday, together with a transformer for raising the potential of the alternating current to 100,000 volts.

INDUCTOSCRIPTS.

THE well-known "breath figures" of Möser, Riess, and Karsten suggested to Mr. F. J. Smith, M.A., in 1878, the idea of producing similar figures on photographic plates. Grove once tried to set the image by coating an electrified plate with collodion and nitrate of silver, but he did not let the electrical discharge act upon the silver salt. Karsten failed to produce fixed pictures of these breath figures on daguerrotype plates, whilst Möser's water-vapour pictures were not permanent effects.

By means of an ingenious combination of apparatus Mr. Smith has recently succeeded in producing these figures on photographic plates under varying circumstances. The experiments were performed under a bell-jar, A, B (*vide* figure).



This was placed on the plate, C, D, of an air-pump; a round copper disc, E, was supported on the pump-plate on three points; on this disc a sensitive plate, F, was placed, and on this the coin, the print of which was to be produced.

The electricity was introduced through the copper rod, K, the plate and rod being connected to the terminals of an inductorium or transformer, driven by four accumulators in series, each having seven plates, 12 inches × 12 inches.

By means of the curved tube, L, different gases were introduced into the bell-jar. The intensity of the spark could be regulated by bringing the terminals of the inductorium together. The output of the transformer was regulated by resistances put into the primary circuit; also by the rate at which the reversing commutator was driven; this commutator was similar to that used on the early Siemens machine.

The gases used were air, oxygen, and coal-gas; the pressure in the receiver was generally 760 mm.; the time of exposure varied from 2 to 50 seconds, the temperature from 5° to 100° C. The best results were obtained with oxygen gas.

Mr. Smith's experiments were entirely successful. In addition to pictures on photo plates, good impressions were obtained on bromide paper and other papers direct; he also obtained good pictures from woodcuts after they had been liberally sprinkled with plumbago. These pictures, of course, were produced on development in the usual way.

These experiments show that a potential difference greatly under that of a jar discharge or that of an electric machine will upset the chemical equilibrium of a photo plate. But several factors appear to contribute to the result, namely: the potential difference, the gas in which the experiment is performed, the pressure under which the experiment is conducted, and the history of the plate previous to the experiment.

Mr. Smith proposed to call these pictures "inductoscripts," a name which somewhat suggests the nature of the process without being hybrid in construction. The paper in which he describes his experiments may be consulted in the *Proceedings of the Physical Society*, Vol. xi., Part iv., pp. 353—356.

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

EXPERIMENTAL RESEARCHES ON ALTERNATE CURRENT TRANSFORMERS. By J. A. FLEMING, M.A., D.Sc., F.R.S., Member. (Read November 24th.)

(*Continued from page* 681.)

It will be observed that we used a row or rows of 24, or less, 50 C.P. incandescent lamps as our non-inductive resistance, and determined the actual resistance at any instant by observing the terminal P.D. of the row of lamps, and the current flowing through them as measured by the fall in volts down a small known non-inductive resistance placed in series with them. We found this to be a better method than using any form of ammeter in series with the lamps—firstly, because we were more sure of not introducing prejudicial inductance into the lamp circuit; and, secondly, because we found we could obtain greater accuracy in the measurement of the current than by any other ammeter suitable for the purpose. The justification for using such a row of lamps as a practically non-inductive resistance is that if an incandescent lamp is placed in series with a dynamometer suitable for measuring both alternating and continuous currents, and if the terminal P.D. on the lamp is adjusted, say, to 100 volts as measured by an electrostatic voltmeter, no sensible difference can be found in the current as measured by the dynamometer, whether that current is alternating or continuous.

It will be seen that when the transformer under test is loaded on its secondary circuit, in addition to the ammeter and voltmeter measurements necessary to estimate the secondary load, we have four, and sometimes five, other voltmeter measurements to make simultaneously in order to get one observation of the power absorbed in the transformer. In dealing with the mere theory of an experimental method, nothing is easier than to say, "Let v be a constant P.D.;" but in actual practice, and when working off the mains of existing public electric supply companies, this ideal condition is very difficult to realise, and the observers have their patience strained often almost up to the safe working limits to obtain any results worth having at all. We found that the multiplicity of readings to take simultaneously constituted a very great drawback to the utility of this voltmeter method. Having the apparatus, however, set up, and the instruments all calibrated, the method was applied to measure the power absorbed in a number of transformers with open secondary circuits, and in one or two cases the power taken up in the transformer corresponding to various secondary loads was also taken.

6. The results of some of these observations are given in the fourth column of Table I., in which the determinations of the power-absorption of various transformers at no load obtained by different methods are collected. In this table the first column gives the maximum output in watts of the transformer; the second gives the "magnetising current," or primary current, at no load; the third the primary volts, or P.D. at the primary terminals; the fourth, fifth, sixth, and seventh columns give various power determinations; the eighth gives the "apparent watts" absorbed at no load, or the numerical product of magnetising current and primary volts; and the ninth column gives a number which it is convenient to call the *power-factor* of the transformer at no load—it is the ratio of the *true* to the *apparent* watts. If the currents and pressures were simple sine functions, then the power-factor in that case would be the cosine of the angle of lag of primary current behind the primary terminal potential difference.

TABLE I.—*Power Absorbed by various Transformers with Open Secondary Circuits at a Frequency of* 83 ~.

Transformers.	1 Maximum output in watts from secondary.	2 Magnetising current in ampères.	3 Primary volts.	4 Powers in watts absorbed at no load. By voltmeter method.	5 By ammeter method.	6 By dynamometer wattmeter, w.	7 By Swinburne wattmeter.	8 Apparent power, w'.	9 Power-factor, w/w'.
Ferranti (1885 pattern)	1,875	·18	2,416	288	—	—	—	432	·66
„ (1885 pattern)	3,750	·337	2,400	540	580	549	511	808	·68
„ (1885 pattern)	7,500	·25	2,435	444	—	—	—	600	·74
„ (1885 pattern)	11,250	·34	2,447	578	—	—	—	816	·70
„ (1885 pattern)	15,000	·57	2,389	1,019	—	—	—	1,368	·75
„ (1885 pattern, re-wound)	3,750	·11	2,400	—	—	233	220	264	·88
„ (1892 pattern)	7,500	·075	2,400	—	—	138	—	180	·77
„ (1892 pattern)	11,250	·076	2,400	—	—	148	116	182	·81
„ (1892 pattern)	15,000	·112	2,400	—	—	228	195	269	·85
„ (1892 pattern, re-wound)	11,250	·103	2,400	—	—	228	—	247	·92
Swinburne, 'Hedgehog'	3,000	·74	2,400	112	111	112	74	1,775	·063
Westinghouse ...	6,500	·05	2,400	93·5	97	95	95	120	·79
Mordey-Brush* ...	6,000	·076	2,400	126	—	140	106	182	·77
„ ...	750	·0317	2,392	61·5	...	—	—	76	·81
Thomson-Houston ...	4,500	·083	2,400	—	-	108	83	199	·54
Kapp	4,000	·145	2,400	—	—	152	112	348	·61

* The power determination by the three-voltmeter method, viz., 126 watts, was made on one transformer, No. 1,952. The power determination by the dynamometer, viz., 140 watts, is the mean of four values obtained on another transformer, No. 1,868, one value of which is also 126 watts.

In criticising these results, it must be borne in mind that several of the transformers were intended to be used at a frequency of 100 and not at 83, and that therefore comparisons between the resulting numbers are not to be instituted without regard to this circumstance. Moreover, on different days the frequency varied from 83 to 88, and this appreciably affects the power determinations. As an example of a series of voltmeter tests, we give in Table II. the details of the observations on a series of transformers at no secondary load. In these tables, v_1 is the voltmeter reading of the P.D. of the primary terminals of the transformer under test; v_2 is the P.D. between the ends of the non-inductive resistance, R; v_3 is the P.D. between the terminals of the pressure-supplying transformers; and w is the power in watts being taken up in the tested transformer, calculated by the formula from the three-voltmeter readings. The frequency employed in each case is stated, and the value of R, the non-inductive resistance, is also given in each case. The column headed "By Swinburne wattmeter" records the power readings taken with the first wattmeter in a brass case, sent with the 3,000-watt Hedgehog transformer. Quite lately another wattmeter, with an ebonite outer case, was sent. This will be afterwards referred to as the "second wattmeter."

TABLE II.—*Tests of Power absorbed on Open Secondary Circuit by various Transformers, taken by the Three-Voltmeter Method.*

(1.) *Westinghouse Transformer*, 6,500-watt. R = 9,678 ohms; frequency = 86·7 ~; magnetising current = 0·049 ampère.; power-factor, 079; apparent watts taken up at no load, 118.

Voltmeter readings. v_1.	v_2.	v_3.	Power absorbed in watts on open secondary circuit.
2,403	490	2,793	92·3
2,384	480	2,777	92·7
2,379	480	2,775	93·5
2,384	480	2,782	94·2
2,386	480	2,786	95·0

Mean = 93·5 watts.

(2.) *Mordey Transformer*, 6,000-watt. R = 12,620; frequency = 82·7 ~; magnetising current, 0·0724 ampère; power-factor, 0·72; apparent watts taken up at no load, 173·7.

Voltmeter readings. v_1.	v_2.	v_3.	Power absorbed in watts on open secondary circuit.
2,419	922	3,158	128
2,420	920	3,142	125
2,410	914	3,133	126
2,406	914	3,130	126
2,402	910	3,122	125
2,410	914	3,140	127
2,406	914	3,135	127

Mean = 126 watts.

TABLE II.—*continued.*

(3.) *Ferranti Transformer*, 7,500-watt (old form, 1885 pattern). R = 8,000 ohms; frequency, 87·2 ~; magnetising current, 0·25 ampère; power-factor, 0·74; apparent watts taken up at no load, 600.

Voltmeter readings. v_1.	v_2.	v_3.	Power absorbed in watts on open secondary circuit.
2,404	2,039	4,134	447
2,439	2,042	4,158	448
2,416	2,042	4,131	442
2,445	2,042	4,160	447
2,445	2,039	4,148	442
2,450	2,035	4,158	438
2,455	2,018	4,153	446

Mean = 444 watts.

NOTE.—The 1892 pattern Ferranti 7,500 watt transformer only takes up 138 watts on open secondary.

The above extracts from the laboratory note-book will be sufficient to show the nature of the observations when typical instances of closed magnetic circuit transformers were under test. All these transformers have about the same power-factor at no load. Several other transformers were tested in the same way, and the mean results are given in the fourth column of Table I.

TABLE III.—*Power in Watts Absorbed by Swinburne "Hedgehog" Transformer* (3,000-*watt*) *at No Load. Taken by the Three-Voltmeter Method.*

Frequency = 82·7 ~; R = 3,297 ohms; magnetising current, 0·73 ampère; power-factor, 0·088; apparent watts taken up at no load, 1,752.

Voltmeter readings. v_1	v_2.	v_3.	Power absorbed in watts.	Frequency = 82.7 ~.
2,379	2,408	3,540	162	
2,380	2,412	3,542	160	
2,387	2,415	3,547	159	
2,381	2,413	3,546	163	
2,380	2,411	3,520	138	R = 3,297 ohms.
2,394	2,423	3,547	148	
2,382	2,415	3,542	151	
2,380	2,412	3,532	150	

Mean value = 155.

TABLE IV.—*Three-Voltmeter Readings on "Hedgehog" Transformer at No Load.—Second Set.*

Frequency = 86·4 ~; magnetising current, = 0·716 ampère.

Voltmeter readings. v_1.	v_2.	v_3.	Power absorbed in watts.	R.
2,400	1,219	2,798	171	1,700 ohms.
2,400	1,206	2,762	123	1,682 „
2,400	1,200	2,723	64	1,678 „
2,400	1.200	2.736	85	1,676 „
2,400	1,200	2,733	80	1,676 „
2,400	1,200	2,736	85	1,678 „

Mean value = 101.

Third Set.

Frequency = 83·2 ~; magnetising current, 0·765 ampère.

Voltmeter readings. v_1.	v_2.	v_3.	Power absorbed in watts.	R.
2,400	2,342	3,436	90	3,069 ohms.
2,400	2,372	3,447	80	3,080 „
2,400	2,372	3,472	87	3,069 „
2,400	2,361	3,441	82	3,078 „
2,400	2,354	3,441	87	3,069 „

Mean value = 85.

7. The application of the three-voltmeter method to closed magnetic circuit transformers, or transformers with large power factors at no load, showed that it was possible, with care, to obtain very fairly good power determinations agreeing well with one another; although the number of instruments to be read rendered it exceeding difficult, unless the pressure was absolutely steady, to get the benefit of the full possible individual accuracy of each instrument. The moment, however, that we turned attention to transformers with small power-factor, such, for instance, as the Swinburne "Hedgehog," the difficulty of obtaining very consistent results was considerably increased. The reason for this is fully explained in a paper by Prof. Ayrton and Dr. Sumpner, "On the Measurement of the Power given by any

Electric Current to any Circuit" (*Proc. Roy. Soc.*, London, Vol. xlix., p. 434, 1891).

Assuming currents and potentials to vary harmonically, they show that if the same percentage error, e, is made in reading each voltmeter, the percentage error in the calculated power will be

$$\sqrt{\frac{2 + 4\,(1 + \cos\phi)^2}{\text{Cos}^2\,\phi}}$$

times e, where cos ϕ may be approximately taken to be the same quantity as that which we have above called the *power-factor*. Hence, if $e = 1$ and cos $\phi = 0{\cdot}75$, the multiplier is found to be 5; but if $e = 1$ and cos $\phi = 0{\cdot}06$, then the multiplier is 40. In other words, a uniform error of 1 per cent. in the voltmeter readings makes only 5 per cent. error in the power when operating on a closed-circuit transformer; but a 1 per cent. voltmeter error means a 40 per cent. error in the power when testing a "Hedgehog." Hence, unless the very greatest constancy in the alternating pressure can be obtained, the three-voltmeter method will not give good results when applied to an open magnetic circuit transformer. In order to show the extent of variation of the power determinations from the mean value, when applying the three-voltmeter method to a "Hedgehog" transformer on open secondary circuit, the individual values obtained on different occasions are grouped together in Tables III. and IV.

In the first set of observations (Table III.) R was kept constant, and the values of v_1 varied slightly; in the second and third set (Table IV.) v_1 was kept absolutely constant, and R was adjusted to make this the case. In the third set the conditions for greatest accuracy were best obtained, v_1 being kept constant, and v_2 made as nearly as possible equal to v_1 by varying R as required. It will be seen that these results were obtained at slightly different frequencies, and that hence they are not, strictly speaking, quite comparable. But as the divergency of results due to change of frequency is quite masked by other causes of error, we need not attend to it. The mean value of the power absorbed by the open-circuit "Hedgehog" in these experiments was respectively 155, 101, and 85 watts at no load. The mean of the means is 114 watts. Besides the above experiments, a number of other quite similar ones were made with the same method, which gave results as follows, viz.: 111, 100, 132, 97, 118, 118, 119, 114, 98, 95, 103, and 88 watts. The mean of all the 30 determinations made with the three-voltmeter method is 112 watts. This is, therefore, the mean result for the power in watts absorbed by the 3,000-watt "Hedgehog" transformer on open secondary circuit when worked at a frequency between 83 and 88. The greatest value of the watts is 171, and the least 64; and the greatest deviation from the mean is 49 watts, or, roughly, 50 per cent. The transformer was marked by the maker to be worked at 100 periods per second. We used it at 83 to 88. It appears, therefore, that, owing to the low power-factor of this transformer, it is a bad subject for the three-voltmeter method, and that even with the greatest precautions considerable deviations from the mean may occur in making a series of power measurements in its case. Nevertheless, it will be shown later on that there is reason to believe that the mean value so obtained of the power absorbed at no load—viz., 112 watts—is not far wrong.

8. As regards the three-voltmeter method itself, considered as a practical method of measuring alternating current power, the following conclusions were impressed upon us:—

(1) It is only applicable in cases when a very steady alternating pressure can be obtained of the requisite amount, and it is therefore unsuitable in general for working as a workshop method, or off commercial alternating circuits.

(2) Owing to the number of instruments to read, it is difficult to carry it out as a practically useful method without the assistance of several observers.

(3) It is especially difficult, if not impossible, to get good results with it when applying it to test transformers of open magnetic circuit type, and having therefore a small power factor.

(4) Unless all the conditions for maximum accuracy can be secured, owing to the nature of the formula for the calculation of the power, the results will not be very trustworthy.

9. In applying the method to measure the power taken up in the primary circuit of a transformer when the secondary circuit is loaded up, the non-inductive resistance, R, must be capable of passing the full primary current required, and yet be capable of being so adjusted that at each stage of the load the fall of volts, v_2, down this resistance is approximately equal to the pressure, v_1, on the terminals of the primary of the transformer being tested. It is essential that this last condition shall hold good, or else we do not obtain the same probability of accuracy in the calculated value of the power given to the primary circuit at all loads. It was found, therefore, that the most convenient arrangement to employ for the non-inductive resistance was one or more parallel series of incandescence lamps. We employed one series of 24 50-C.P. 100-volt lamps, and two series of 24 16-C.P. 100-volt lamps, the three series being arranged in parallel when required, and any required number out of the 24 lamps in each series taken. In order to measure the resistance at any instant of this bank of lamps, the second set of six non-inductive resistance coils was arranged in series with the lamps, and the drop in volts down this known resistance measured with the Kelvin electrostatic voltmeter. This gave us the current flowing through the lamps, and the Swinburne voltmeter gave us the P.D. over lamps and resistance. Hence, knowing the terminal P.D. and the current, we have the value of the non-inductive resistance, r_1, at any instant given by the inspection of two voltmeters. In making the full tests at all loads of a transformer by this method, the power given out from the transformer was taken up on a bank of incandescent lamps, and the current and terminal volts measured by a Kelvin balance and Kelvin multicellular electrostatic voltmeter. The results of a double series of observations on a Ferranti 5-H.P. 1885 (old form) transformer, and those on a Swinburne 3,000-watt "Hedgehog," are tabulated in Tables V., VI., VII., and VIII.

TABLE V.—*Ferranti Transformer* (1885 *pattern*).

No. 747. Power = 5 H.P. Secondary volts = 100.
Frequency used, 81·7 periods per second.
Average final temperature of transformer, 212° F.
Volts on primary circuit (v_1) = 2,400 (kept constant).
Primary circuit resistance = 12·50 ohms at 212° F.
Secondary circuit resistance = 0·0252 ohm at 212° F.
Results plotted in a curve in fig. 3.*

Secondary circuit.			Primary circuit.						
Volts.	Amperes.	Watts, w_2.	Amperes.	Resistance, r_1.	Observed volts. v_1.	Observed volts. v_2.	Observed volts. $\frac{1}{2}v_3$	Watts, w_1.	Total power taken up in transformer $= w_1 - w_2$.	Efficiency $= \frac{w_2}{w_1}$ in per cents.
100·4	0	0	0·336	7,595	2,400	2,552	2,242	516	516	0
100·4	0	0	0·341	7,580	„	2,585	2,242	516	516	0
100·2	0	0	0·336	7,600	„	2,555	2,242	504	504	0
100·9	0	0	0·341	6,190	„	2,111	2,056	540	540	0
100·8	0·57	57	0·363	6,129	„	2,225	2,103	569	512	10·0
100·7	1·57	158	0·400	6,037	„	2,415	2,234	693	535	22·8
100·7	2·72	273	0·443	5,988	„	2,653	2,374	815	542	33·5
100·5	3·82	384	0·481	4,625	„	2,225	2,187	910	536	42·2
100·4	4·87	489	0·525	4,537	„	2,382	2,278	1,020	531	48·0
100·3	7·20	722	0·587	3,901	„	2,290	2,266	1,222	500	59·1
100·3	8·72	874	0·661	3,821	„	2,526	2,393	1,409	535	62·0
100·5	10·58	1,063	0·735	3,096	„	2,276	2,278	1,584	521	67·2
100·0	12·49	1,249	0·802	3,045	„	2,442	2,385	1,810	561	69·0
100·0	14·28	1,428	0·867	2,651	„	2,299	2,313	1,954	526	73·0
100·0	16·00	1,600	0·936	2,285	„	2,139	2,238	2,149	549	74·4
99·9	17·66	1,764	1·010	2,253	„	2,276	2,313	2,321	557	76·0
99·8	19·80	1,976	1·094	1,900	„	2,079	2,207	2,476	500	79·8
99·5	22·72	2,261	1·215	1,865	„	2,267	2,309	2,790	529	81·1
99·5	24·82	2,470	1·298	1,851	„	2,403	2,389	3,050	580	81·1
99·4	27·64	2,747	1·412	1,502	„	2,121	2,242	3,284	537	83·6
99·2	30·07	2,983	1·516	1,486	„	2,253	2,313	3,554	571	84·0

NOTE.—The column headed $\frac{1}{2}$ v_3 gives the values of half the total pressure across the terminals of the two pressure-producing transformers.

TABLE VI.—*Ferranti Transformer* (1885 *Pattern*).

No. 747. Power = 5 H.P. Secondary volts = 100.
Frequency used, 84·8 periods per second.
Average final temperature of transformer, 212° F.
Volts of primary circuit (v_1) = 2,400 (kept constant).
Primary circuit resistance = 12·50 ohms at 212° F.
Secondary circuit resistance = 0·0252 ohm at 212° F.

Secondary circuit.			Primary circuit.						
Volts.	Amperes.	Watts, w_2.	Amperes.	Resistance, r_1.	Observed volts. v_1.	Observed volts. v_2.	Observed volts. $\frac{1}{2}v_3$	Watts, w_1.	Total power taken up in transformer $= w_1 - w_2$.	Efficiency $= \frac{w_2}{w_1}$ in per cents.
100 2	0	0	0·332	7,512	2,400	2,494	2,221	516	516	0
100·5	0	0	0·328	7,603	„	2,494	2,221	509	509	0
100·9	0	0	0·329	6,209	„	2,043	2,039	538	538	0
100·9	2·10	212	0·403	6,079	„	2,450	2,291	759	547	28·0
100·1	3·99	400	0·474	4,109	„	1,948	2,078	839	439	43·0
100·2	6·33	634	0·554	3,776	„	2,190	2,217	1,205	571	52·0
99·9	9·80	979	0·686	3,495	„	2,395	2,345	1,503	524	65·0
100·0	12·65	1,265	0·795	2,700	„	2,143	2,236	1,786	521	71·0
99·8	14·70	1,467	0·888	2,630	„	2,338	2,329	1,989	522	74·0
99·7	17·44	1,738	1·000	2,258	„	2,255	2,299	2,283	545	76·0
99·7	21·26	2,120	1·155	1,879	„	2,163	2,260	2,658	538	83·0
99·6	23·07	2,298	1·236	1,870	„	2,306	2,337	2,880	582	80·0
99·3	25·38	2,520	1·323	1,510	„	1,996	2,181	3,075	555	82·0
99·1	26·46	2,622	1·368	1,500	„	2,055	2,217	3,226	604	81·5
98·9	28·00	2,770	1·430	1,498	„	2,140	2,256	3,344	574	83·0
99·0	29·53	2,924	1·493	1,505	„	2,230	2,295	3,434	510	85·0
99·0	30·13	2,983	1·517	1,485	„	2,253	2,325	3,630	647	82·0
98·9	31·11	3,077	1·559	1,482	„	2,309	2,345	3,680	603	83·5
98·9	32·06	3,171	1·601	1,472	„	2,361	2,369	3,775	604	84·0
99·0	33·41	3,308	1·659	1,290	„	2,140	2,256	3,953	645	83·5
99·0	34·35	3,401	1·695	1,289	„	2,181	2,291	4,066	665	84·0
98·9	35·50	3,511	1·743	1,289	„	2,242	2,322	4,182	671	84·0
98·8	36·00	3,557	1·763	1,283	„	2,264	2,329	4,218	661	84·4
98·8	36·61	3,617	1·796	1,276	„	2,291	2,341	4,275	658	84·5
98·7	37·09	3,669	1·821	1,268	„	2,312	2,361	4,414	745	84·5
98·6	37·58	3,718	1·839	1,272	„	2,341	2,369	4,406	688	84·5
98·5	38·11	3,754	1·861	1,270	„	2,364	2,380	4,453	699	84·5
98·5	38·57	3,800	1·875	1,274	„	2,389	2,395	4,503	703	84·5
98·5	39·19	3,860	1·900	1,267	„	2,407	2,406	4,580	720	84·0

In these tables the first three columns give the volts, current, and watts output, w_2, of the secondary circuit; the fourth column gives the primary current; the fifth the value of the inductionless resistance in series with the primary; the sixth, seventh, and eighth columns give the values of the voltmeter readings, v_1, v_2, and v_3; the column headed w_1 is the calculated value of the power given to the primary circuit; the last two columns give the value of $w_1 - w_2$, or the total power in watts absorbed in the transformer,

* As this figure is referred to again later on it will appear in our next issue.—EDS. ELEC. REV.

and the ratio $\frac{w_2}{w_1}$, or the efficiency, expressed as a percentage. The values of $w_1 - w_2$ are the total power in watts dissipated in the transformer, partly as copper frictional losses (c^2 R losses), partly as iron losses (eddy current and hysteresis), and in any other way, such as eddy currents in the copper circuits by which internal work is being expended.

Table VII.—*Swinburne "Hedgehog" Transformer.*

No. 342. Power = 3,000 watts. Secondary volts = 100.
Frequency used, 83·7 periods per second.
Average final temperature of transformer, 147° F.
Volts on primary circuit (v_1) = 2,400 (kept constant).
Primary circuit resistance = 24·00 ohms at 145° F.
Secondary circuit resistance = 0·051 ohm at 145° F.

Secondary circuit.			Primary circuit.						Total power taken up in transformer $= w_1 - w_2$.	Efficiency $= \frac{w_2}{w_1}$ in per cents.
Volts.	Amperes.	Watts $= w_2$.	Amperes.	Resistance $= r_1$.	Observed volts.			Watts $= w_1$.		
					v_1.	v_2.	v_3.			
102·0	0	0	0·738	3,101	2,400	2,289	3,424	118	118	0
102·0	0	0	0·738	3,105	„	2,293	3,429	118	118	0
102·0	0	0	0·738	3,105	„	2,293	3,430	119	119	0
102·0	0	0	0·738	3,106	„	2,295	3,430	118	118	0
101·9	1·06	108	0·759	3,069	„	2,314	3,542	232	124	46·6
101·9	2·12	216	0·763	3,069	„	2,342	3,667	316	100	68·4
101·9	2·71	276	0·769	3,070	„	2,361	3,733	422	146	65·5
101·8	4·20	427	0·775	3,057	„	2,370	3,808	510	83	83·8
101·5	9·38	952	0·882	3,979	„	2,627	4,338	1,033	81	92·0
101·0	12·65	1,278	0·969	2,938	„	2,847	4,694	1,391	113	91·8
100·5	15·62	1,570	1·050	2,585	„	2,714	4,658	1,657	87	94·8
100·2	19·00	1,904	1·161	2,220	„	2,578	4,612	1,997	93	95·5
100·0	21·68	2,168	1·255	1,863	„	2,338	4,438	2,258	90	96·0
99·0	30·10	2,980	1·578	1,470	„	2,320	4,530	3,189	209	93·5
102·0	0	0	0·756	3,073	„	2,323	3,444	114	114	0

Table VIII.—*Swinburne "Hedgehog" Transformer.*

No. 342. Power = 3,000 watts. Secondary volts = 100.
Frequency used, 82·3 periods per second.
Average final temperature of transformer, 145° F.

Secondary circuit.			Primary circuit.						Total power taken up in transformer $= w_1 - w_2$.	Efficiency $= \frac{w_2}{w_1}$ in per cents.
Volts.	Amperes.	Watts $= w_2$.	Amperes.	Resistance $= r_1$.	Observed volts.			Watts $= w_1$.		
					v_1.	v_2.	$\frac{1}{2} v_3$.			
102·1	0	0	0·760	3,060	2,400	2,326	1,716	98	98	0
101·9	0	0	0·759	3,053	„	2,317	1,711	95	95	0
102·0	0	0	0·759	3,056	„	2,320	1,716	103	103	0
102·0	0·57	58	0·760	3,060	„	2,326	1,736	144	86	40·0
101·9	1·26	128	0·761	3,068	„	2,335	1,762	197	69	65·0
101·9	1·74	177	0·769	3,043	„	2,373	1,805	269	92	66·0
102·0	2·33	238	0·777	3,078	„	2,391	1,830	313	75	76·0
101·9	2·91	297	0·784	3,074	„	2,410	1,862	375	78	79·0
101·6	4·00	406	0·799	3,060	„	2,445	1,912	472	66	86·0
101·4	5·59	567	0·834	3,035	„	2,532	2,021	687	120	83·0
101·5	8·25	837	0·857	2,981	„	2,555	2,119	951	114	88·0
101·4	10·58	1,073	0·915	2,966	„	2,714	2,242	1,177	104	91·0
101·0	12·96	1,309	0·957	3,000	„	2,871	2,370	1,411	102	93·0
100·8	15·23	1,537	1·043	2,584	„	2,696	2,323	1,658	121	93·0
100·5	17·09	1,718	1·098	2,240	„	2,460	2,230	1,800	82	95·5
100·5	19·29	1,938	1·169	1,899	„	2,218	2,123	1,938	—	100·0
100·0	21·45	2,145	1·248	1,861	„	2,323	2,238	2,382	237	90·0
99·8	23·07	2,302	1·304	1,531	„	1,997	2,073	2,411	109	95·5
99·7	24·74	2,467	1·366	1,519	„	2,076	2,111	2,558	91	96 5
99·5	25·77	2,564	1·403	1,511	„	2,121	2,123	2,570	6	99·5
99·5	26·31	2,618	1·423	1,509	„	2,145	2,152	2.702	84	97 0
99·4	26·83	2,667	1·447	1,506	„	2,178	2,163	2,724	57	98·0
99·1	27·42	2,718	1·466	1,497	„	2,196	2,183	2,821	103	96·0
99·0	27·85	2,758	1·485	1,498	„	2,225	2,199	2,881	123	96·0
99·0	28·43	2,815	1·504	1,496	„	2,250	2,207	2,898	83	97·0
98·9	28·9	2,867	1·528	1,489	„	2,276	2,226	2,980	113	96·0
98 8	29·40	2,915	1·543	1,484	„	2,290	2,238	3,040	121	96·0
98·8	29·93	2,957	1·566	1,481	„	2,320	2,250	3,075	118	96·0
102·1	0	0	0·759	3,080	„	2,338	1,716	83	88	0

(*To be continued.*)

ELECTRICAL STANDARDS.

The following supplementary report has been presented by the Electrical Standards Committee:—

To the Right Hon. A. J. Mundella, M.P., *President of the Board of Trade.*

Subsequently to the presentation of our former report to Sir Michael Hicks-Beach, in July, 1891, we were informed that it was probable that the German Government would shortly take steps to establish legal standards for use in connection with electrical supply; and that with a view to secure complete agreement between the proposed standards in Germany and England, the director of the Physico-Technical Imperial Institute at Berlin, Prof. von Helmholtz, with certain of his assistants, proposed to visit England for the purpose of making exact comparisons between the units in use in the two countries, and of attending the meeting of the British Association which was to take place in August in Edinburgh.

Having regard to the importance of this communication, it appeared desirable that the Board of Trade should postpone the action recommended in our previous report, until after Prof. Helmholtz's visit. That visit took place early in August, and there was a very full discussion of the whole subject* at the meeting of the British Association, in Edinburgh, at which several of our number were present. The meeting was also attended by Dr. Guillaume, of the Bureau International des Poids et Mesures, and Professor Carhart, of the University of Michigan, U.S.A., who were well qualified by their scientific attainments to represent the opinion of their respective countries.

It appeared from the discussion that a few comparatively slight modifications of the resolutions included in our previous report would tend to secure international agreement.

An extract from the report of the Electrical Standards Committee of the British Association, embodying the results of this discussion, was communicated to us by the secretary, and will be found in the appendix to this report.

Having carefully re-considered the whole question in view of this communication, and having received the report of the sub-committee mentioned in resolution 14 of our previous report, we now desire, for the resolutions contained in that report, to substitute the following:—

Resolutions.

1. That it is desirable that new denominations of standards for the measurement of electricity should be made and approved by Her Majesty in Council as Board of Trade standards.

2. That the magnitudes of these standards should be determined on the electro-magnetic system of measurement with reference to the centimetre as unit of length, the gramme as unit of mass, and the second as unit of time, and that by the terms centimetre and gramme are meant the standards of those denominations deposited with the Board of Trade.

3. That the standard of electrical resistance should be denominated the ohm, and should have the value 1,000,000,000 in terms of the centimetre and second.

4. That the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice 14·4521 grammes in mass of a constant cross sectional area, and of a length of 106·3 centimetres may be adopted as one ohm.

5. That a material standard, constructed in solid metal, should be adopted as the standard ohm, and should from time to time be verified by comparison with a column of mercury of known dimensions.

6. That for the purpose of replacing the standard, if lost, destroyed, or damaged, and for ordinary use, a limited number of copies should be constructed, which should be periodically compared with the standard ohm.

7. That resistances constructed in solid metal should be adopted as Board of Trade standards for multiples and sub-multiples of the ohm.

8. That the value of the standard of resistance constructed by a committee of the British Association for the Advancement of Science in years 1863 and 1864, and known as the British Association unit, may be taken as ·9866 of the ohm.

9. That the standard of electrical current should be denominated the ampère, and should have the value $\frac{1}{10}$th (0·1) in terms of the centimetre, gramme, and second.

10. That an unvarying current which, when passed through a solution of nitrate of silver in water, in accordance with the specification attached to this report, deposits silver at the rate of 0·001118 of a gramme per second may be taken as a current of 1 ampère.

11. That an alternating current of 1 ampère shall mean a current such that the square root of the time average of the square of its strength at each instant in ampères is unity.

12. That instruments constructed on the principle of the balance, in which, by the proper disposition of the conductors, forces of attraction and repulsion are produced, which depend upon the amount of current passing, and are balanced by known weights, should be adopted as the Board of Trade standards for the measurement of current whether unvarying or alternating.

13. That the standard of electrical pressure should be denominated the volt, being the pressure which, if steadily applied to a conductor whose resistance is 1 ohm, will produce a current of 1 ampère.

14. That the electrical pressure at a temperature of 15° C. between the poles or electrodes of the voltaic cell known as Clark's cell, prepared in accordance with the specification attached to this report, may be taken as not differing from a pressure of 1·434 volts, by more than one part in 1,000.

15. That an alternating pressure of 1 volt shall mean a pressure such that the square root of the time average of the square of its value at each instant in volts is unity.

16. That instruments constructed on the principle of Lord Kelvin's quadrant electrometer used idiostatically, and, for high pressures, instrument on the principle of the balance, electrostatic forces being balanced against a known weight, should be adopted as Board of

* See Electrical Review for August 19th, 1892, page 229.

Trade standards for the measurement of pressure, whether unvarying or alternating.

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KELVIN.	R. T. GLAZEBROOK.
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W. H. PREECE.	W. E. AYRTON.
RAYLEIGH.	

T. W. P. BLOMEFIELD, *Secretary.*

November 29th, 1892.

DURHAM COLLEGE OF SCIENCE, NEWCASTLE.

ON Monday, the foundation stone of what may be described as the second instalment of the building scheme of the Durham College of Science, at Newcastle, was laid with the usual ceremonies by the Earl of Durham, in the presence of a large gathering of the friends of technical education. The foundation stone of the portion of the building now in use was laid by Lord Armstrong in 1887, and already it has been found quite inadequate to the needs of the work carried on, and it is hoped and anticipated that only a few more years will elapse before it will be possible to complete the edifice by the erection of the third instalment. The buildings now in progress will consist principally of a gateway tower erected in commemoration of the Jubilee Exhibition, out of the surplus funds of that undertaking; and a wing to be called the George Stephenson Engineering Laboratory, the ground floor of which is a spacious apartment, 123 feet long by 35 feet wide, with an annexe 90 feet by 10 feet. This will contain a 100-ton testing machine, presented by Mrs. Wm. Clarke, of Gateshead, experimental marine engines, oil testing machine, bar testing machine, cement testing machine, hydraulic and other dynamometers, and a large variety of tools and experimental apparatus in connection with mining, naval construction, and applied mechanics. Power will be available at all points of this laboratory. The first and second floors of this building afford spacious accommodation for lecture rooms, drawing offices, and art galleries. The new building in effect about doubles the present size of the college. The whole building will be heated by exhaust steam from the main engine, and will be lighted throughout by electricity.

Speaking at the luncheon after the ceremony, the Earl of Durham paid a high tribute to the perseverance and zeal of the principal of the college. He remarked that "the college had already turned out many good men, and although, no doubt, that was greatly owing to their abilities and aptitude for learning, still they must not forget that the greatest credit was due to those who had taught them. To Prof. Garnett, and to those who served with him, great praise was due. A man might have great wisdom himself and yet not have the gift of imparting any of his knowledge to others. There had been great scholars, men who had attained to the highest distinction in classical studies, whose brains had been of vast value to themselves but had not been of the slightest use to the community at large. But this could not be laid to the charge of Prof. Garnett and his assistants."

Prof. Garnett in his report stated that the number of students attending the classes and the amount of class fees have increased very largely, the total number of students reaching 2,148. Several additions have been made to the teaching staff, and the College has thereby been enabled to undertake a very great amount of work in the adjoining counties. The new departments of agriculture and engineering have made a successful start. In the latter department Mr. R. M. Ferrier, B.Sc. (with honours in engineering), of the University of Glasgow, has been appointed lecturer in machine construction and drawing; in the Agricultural Department Mr. F. O. Solomon, F.H.A.S., of the North-Eastern County School, has been appointed assistant lecturer, his duties being so arranged as to allow him to continue his agricultural teaching at the school. The subscription of £500 from the County Council of Northumberland has been suplemented by an equal contribution from the Board of Agriculture, and the County Council of Durham has agreed to contribute a similar amount. A very valuable collection of apparatus, models, and diagrams has already been secured by the Agricultural Department, partly through the assistance of the Board of Agriculture. The new buildings for the departments of metallurgy, engineering and naval architecture, and fine art, have already made considerable progress, and it is understood that they will be ready for occupation in October, 1893.

In his speech at the luncheon the principal mentioned that during the four years since the college entered upon the premises which they now occupy, the expenditure of the college had more than doubled, and the number of teachers and professors on the staff had been increased in a higher ratio, and the number of students at a still greater rate. The Durham College of Science was one of ten institutions which were recognised by Her Majesty's Treasury as colleges of university rank, and towards which a subsidy was provided by the Treasury, bearing a small but appreciable relation to the contributions made by Her Majesty's Government to the universities of Scotland, Royal Colleges in Ireland, and the university colleges in Wales. The college was one of the same number of institutions which had been entrusted by the Education Department with the training of elementary teachers. It was one of two colleges in England which received substantial subsidies from the Board of Agriculture for the promotion of agricultural teaching. It was recognised by the Admiralty for the training of engineers for the Royal Navy. The most important section of the buildings which were now in course of erection, and the foundation stone of which Lord Durham had so kindly laid that day, was the George Stephenson engineering department. To it he looked with confidence for a higher development of the work of the college than any which had yet taken place. Experience in other places justified this expectation. At Leeds no more engineering students could be received. At Bristol the fees paid for the engineering classes were equal to those in all the other departments of the college together, while students were drawn from all parts of the world. In other colleges the engineering departments were an unqualified success. This district offered a field in importance exceeding all others, and their college would possess an engineering laboratory second to none. It was not for him to say by how much superior to all.

DR. WERNER VON SIEMENS.

IT is with the deepest regret that we have to record the death of Dr. Werner von Siemens, which took place on Tuesday evening last. It is an event which has hovered near for many months. Dr. Siemens had long been ailing, and though at times he appeared to rally from the illness, his condition had been such as to cause the gravest anxiety.

One by one as the great scientific men pass away we seem to lose all touch with the early days of electricity, and past events become matter of history. Time flies fast as we gaze on the achievements of great men, until they are dwarfed, then lost in the vista of years, and the years become an age.

Englishmen and our cousins across the water will mourn the loss of one of the oldest and strongest props of the electrical industry.

Dr. Ernst Werner von Siemens was born in the year 1816 at Lenthe, near Hanover. He was the eldest of a now famous family, his brothers, William, Carl and Frederick having achieved a distinction scarcely second to that of Werner. At the completion of his education at Lubeck, Werner von Siemens entered the Prussian artillery as a volunteer, and upon receiving his officer's commission devoted himself to the study of chemistry and physics.

We can do no more in the space at our command, than give briefly the chief points in the work of this remarkable man. Full justice can be only given in a special treatise, and the long promised volume from Germany will fill a gap in the biography of scientific men.

It was in 1839 at Magdeburg that he began his scientific investigations. His first experience was somewhat unfortunate, for an explosion, caused by a preparation of phosphorus and chlorate of potash, burst the drum of his right ear. As he had met with a similar accident to his other ear some time before, he was for a time stone deaf. His studies were fated to be again interrupted, for in the autumn of 1840 he was sentenced to five years' imprisonment for acting as second in a duel.

"Stone walls do not a prison make," was more than exemplified in his case, for being allowed to continue his experiments, he successfully plated a silver spoon with gold. The silver spoon was connected to one pole of a Daniell cell, a *louis d'or* to the other. It was a great disappointment to him, when after a month's imprisonment he was pardoned, and begged that he might be allowed to use his cell to complete some experiments.

A patent was granted him in Prussia in 1841 for electro-gilding and silvering. In 1842 he and his brother, William Siemens, took out a patent for a differential regulator.

In 1844 he was appointed to the artillery workshops in Berlin, where he turned his attention earnestly to telegraphy, and in 1845 patented his dial and printing telegraph instruments, which were based on the self-breaking principle of the Neef's hammer.

These labours led to his being made member of a commission, which was appointed in Berlin in 1846, for the introduction of electric in place of the optical telegraphs, which had been in use up to that time. As member of this commission, Werner Siemens, in the autumn of 1846, recommended gutta-percha (just then becoming known) for the insulation of underground lines. He constructed in the following year (1847) a screw press machine to cover wires with gutta-percha, made plastic by heat, but without a seam.

In 1848 his military duties called him to Kiel, where, in conjunction with his brother-in-law, Prof. C. Himly, he laid down the first electric submarine mines. They served to protect the town of Kiel, and saved it from being bombarded by the Danish fleet.

The Prussian Government in the autumn of 1848 deputed him to lay the first great underground telegraph line from Berlin to Frankfort-on-the-Main, and in the following year another from Berlin to Cologne, Aix-la-Chapelle, and Verviers. Werner von Siemens now left the army and government service, and devoted himself henceforth to scientific pursuits and the management of a telegraph factory, which he and Mr. Halske established in 1847. The firm has since then acquired a world-wide reputation, and is indissolubly connected with the growth and progress of telegraphy. During the laying of the first underground lines Werner von Siemens had observed the then remarkable phenomenon of electrostatic induction, which exercised so retarding an influence in the working of those lines. He described the phenomena in a paper communicated to the Paris Academy of Sciences in the year 1850. The underground system of telegraphs had, however, to give place to the overground, on account of the technical difficulties mentioned. But the experience gained from these failures resulted in overcoming the difficulties, with the result that the lines were relaid underground about 1878.

From the period of 1845 an almost uninterrupted series of scientific and technical discoveries and inventions emanated from him and from the factory under his direction.

In October, 1845, he devised a machine for the measurement of small intervals of time and the speed of electricity by means of electric sparks, and its application in 1875 for measuring the speed of the electric current in overland lines. In January, 1850, he read a paper on telegraph lines and apparatus, in which the theory of the electrostatic charge in insulated lines, as well as methods and formulæ for the localising of faults in underground wires were first established.

The firm of Siemens and Halske, in 1851, erected the first automatic fire telegraphs in Berlin, and in the same year Werner von Siemens wrote a treatise on the experience gained with the underground lines of the Prussian telegraph system. The difficulty of communicating through long underground lines led him to the invention of automatic translation, which was afterwards improved upon by Steinheil; and in 1852 he furnished the Warsaw-Petersburg line with automatic fast-speed writers. The messages were punched in a paper band by means of the well known Siemens lever punching apparatus, and then automatically transmitted in a clockwork instrument.

In 1854, the discovery (contemporaneous with that of Frischen) of simultaneous transmission in opposite directions, and multiplex transmission by means of electromagnetic apparatus was made, and two years later the Siemens magneto-electric dial instrument, giving alternate currents, was constructed. From this apparatus originated the well known Siemens armature, and from the receiver was developed the Siemens polarised relay, with which the working of submarine and other lines could be effected with alternate currents; and in the same year, during the laying of the Cagliari-Bona Cable, the construction and first application of dynamometers, also the development of the theory of submerging cables in deep water took place.

In researches on the subject of electrostatic induction and the retardation of the current in insulated wires representing Leyden jars, Werner von Siemens developed mathematically Faraday's theory of molecular induction, and thereby paved the way in great measure for its general acceptance. The construction of the ozone apparatus, telegraph instruments with alternate currents, and translation and automatic discharge for cable lines, were devised in 1857. The Sardinia, Malta, and Corfu Cable was in the same year worked with such instruments.

In 1859 came the construction of an electrical log; the discovery of the heating of the dielectric by induction; the introduction of a reproducible standard resistance measurer (Siemens's unit); the construction of resistance bobbins and the testing of insulated wires by systematic methods were also effected by him; also researches on the influence of heat on the electrical resistance of metals, and the establishing of methods and formulæ for testing resistances, and for the determination of faults by means of resistance measurements instead of with current measurements as formerly used. These methods were adopted by the electricians to the English Government, Messrs. Siemens Bros., London, during the manufacture of the Malta-Alexandria Cable, which was the first long cable subjected to a system of continuous tests.

Werner von Siemens, in 1861, showed that the electrical resistance of molten alloys is equal to the sum of the resistances of the separate metals, and that latent heat increases the specific resistance of metals in a greater degree than free heat.

In 1864 he made researches on the heating of the sides of a Leyden jar by the electrical discharge. In 1866, the establishing of the theoretical principle of dynamo-electric machines, which led to the construction of dynamo-electric mine exploders and light apparatus. In 1874, a treatise on the theory of the laying and testing of submarine cables; and in May, 1875, researches on the influence of light on crystalline selenium; and in 1876 and 1877 on the change of conducting power of selenium by heat and light.

He had continued reading papers and addresses down to the present time, and had contributed of late years much to the theory of electro-magnetism.

Werner von Siemens's scientific knowledge and inventive genius combined with the great mechanical ability of his partner, Mr. Halske, soon developed the telegraph works of Siemens and Halske in Berlin into a large establishment, from which Mr. Halske retired in 1867. This development was also, to a great extent, owing to the circumstance that the firm produced a number of eminent engineers, who have for the most part remained in their service. Many instruments and new constructions are due to these engineers, whose exertions have largely contributed to the fact that the constructions of the firm are generally recognised and accepted as models. In 1865, Werner von Siemens introduced pneumatic dispatch tubes into Berlin; the system adopted there served as a model for that laid down in London by Siemens Bros. in 1871. The railway signalling and block system of Siemens and Halske, which has been adopted by many Continental railways, was the first to ensure a forced dependence between

the electric and semaphore signals and the position of the points; the automatic cylinder transmitter, with which Morse signals are transmitted from a keyboard and registered automatically; an automatic fast speed printer, electric lamps, &c., are further evidence of the inventiveness of the firm.

In 1879 Werner von Siemens constructed an electric railway in Berlin. The electric energy was transmitted to the moving carriage, or train of carriages, through the two rails upon which it moved, these being sufficiently insulated from each other by being placed upon well creosoted cross sleepers. This railway, which was much used during the Berlin Exhibition of 1879, was the direct progenitor of the Lichterfelde line, one rail serving as the conductor from the dynamo, the other as the return. This railway has continued with success from 1881 down to to-day.

The alcoholometer ranks as one of the most ingenious of Werner von Siemens's inventions. This apparatus registers with perfect accuracy the actual quantity of absolute alcohol contained in the spirit which is passed through it.

About 1,000 workmen were employed at the Berlin telegraph and cable works as early as 1879. Siemens & Halske were among the first to construct telegraph lines in Germany and other countries. In 1854 a branch firm was established at St. Petersburg, under the direction of Carl Siemens, who became a partner. A complete network of Government telegraph lines for Russia was constructed and erected by this firm. In the year 1857 a branch of the firm was established in London, the well known Siemens Bros. of to-day. The development of Siemens & Halske's business since the introduction of electric light and traction is one of the most remarkable facts in industrial enterprise. They have carried out much of the electric light and traction work on the Continent, and the latest development is the opening of a large branch house in America, where it is expected they will compete with advantage with the American manufacturers. For his scientific labours, Werner von Siemens had in the year 1860 the degree of Doctor (*honoris causa*) of the Berlin University conferred upon him, and in the year 1873, he was elected member of the Berlin Royal Academy or Sciences. The Patent of Nobility was bestowed upon him in 1888 by Frederick III. He was for a long time member of the Prussian Parliament, and the Vice-President of the Society for the Advancement of Industry in Berlin; he was also member of the Asiatic Society in Calcutta, and hon. secretary for Germany of the London Society of Telegraph Engineers (now the Institution of Electrical Engineers), and was hon. member of the Institution of Civil Engineers, London, &c., &c.

Not the least important of his many labours was the obtaining for Germany a practical patent law, after agitating this subject for a number of years, in connection with the Society for Patent Protection, which he founded, and of which he was appointed permanent president.

REVIEWS.

Electric Light: Its Production and Use. By J. W. URQUHART. Fifth Edition. London: Crosby Lockwood and Son, 7, Stationers' Hall Court, Ludgate Hill.

The chief change which has been made in this work has been the addition of a chapter on "Control of Central Station Lighting." This chapter, however, consists of but six pages, and deals principally with methods of current regulation, and the arrangement of dynamos and circuits for distributing a current supply economically. The continual issue of new and improved editions of the work are indications that it has made its mark, and that it affords information which many are desirous of obtaining.

The "Practical Engineer" Pocket-Book and Diary, 1893. Edited by W. H. FOWLER. London: John Heywood, 2, Amen Corner. Manchester: Technical Publishing Company, 6, Victoria Station Approach.

This book promises to become a standard work of the kind. Published originally three years ago, each succeeding year has witnessed decided improvements in the compilation. The title is, perhaps, a little misleading, as "Practical Engineer" does not necessarily mean "mechanical" engineer, and the book only touches subjects with which the mechanical engineer deals. The steam engine practically forms the bulk of the book; the gas engine, hydraulics, and gearing being also included. The book may be considered as a mechanical Molesworth brought up to date; it is certainly a cheap eighteenpenny worth.

NOTES.

Teignmouth Electric Lighting.— A public meeting is to be held to consider the extension of the gas works and the introduction of the electric light.

Asylum Electric Lighting.—A sum of £450 has been granted for the electric lighting of Whittingham (Lancs.) asylum grounds.

Liverpool Electric Lighting.—Extension of electric lighting has been agreed upon at Liverpool. Power has been granted to the Electric Supply Company to lay a main through Sefton Park for lighting the adjoining houses.

Milan Electric Tramway.—The municipal council of Milan has granted a concession to the Edison Company in that town for the establishment of an electric tramway (any system), to commence at the Piazza del Duomo and to terminate at the Porta Sempione. The experiment will be made for a year.

The Driving of Tunnels by Electricity.—A project has been brought forward for the piercing of a large tunnel in the Bouches du Rhone by means of electricity. The length of the proposed tunnel is 4,000 metres.

Coventry Electric Tramways.—A lengthy report has been drawn up regarding the overhead wire system of electric traction which is the system proposed to be introduced into Coventry by Mr. W. S. Graff Baker, who, we understand, has recently purchased the Coventry and district tramways.

St. Pancras Electric Lighting.—The *Daily Chronicle* says that difficulties having arisen in placing the arc lamps in the middle of many of the streets owing to tramlines, the vestry will be compelled to depart from the original scheme and place the lamps at the edge of the pavement.

Complaints have been made that the electric lighting is not so brilliant as it was a few months ago.

Dundee Electric Lighting Progresses. — Although frost for the last few days has retarded the electric light work much progress has been made. Heads of business houses have already applied for light to the extent of 1,300 C.P. It is expected when the station is opened that the full supply will have been applied for. The contractors hope that current will be supplied at the end of the year.

Brighton Electric Lighting.—A *Sussex Daily News* correspondent says that recently he required a supply of electricity for business purposes at Brighton and applied to the Corporation. He was informed that he must either pay for laying the cables from Western Road or induce one-fourth of the inhabitants of the street to become consumers. Not being disposed to go to that expense, he applied to the Brighton and Hove Electric Light Company who promptly satisfied his wants and brought their cables to his premises free of charge. He therefore considers that it would be unwise to allow any electric lighting monopoly at Brighton.

The reports of Mr. Wright regarding extensions of electric lighting at Brighton which we gave in an article in our last issue have been adopted.

Institution of Electrical Engineers.—The annual general meeting was held last evening (December 8th), for the reception of the annual report of the council and election of council and officers for the year 1893. There was also a continuation of the discussion on Dr. Fleming's paper on "Experimental Researches on Alternate Current Transformers."

South African Telegraphs.—In his remarks at a recent meeting of the British South Africa Company, the chairman said that a very important means of spreading civilisation consisted in the introduction of the post and telegraph system. The telegraph was already at Fort Salisbury, and with the construction of the East Coast Railway there must be a telegraph between Fort Salisbury and Beira. The company might look forward to the day when the wires would stretch across the entire field of its operations.

Kingswood Electric Lighting.—It is stated that the installation at Kingswood is completed and the photometer ready at the Kingswood Electric Light Station for the surveyor's use. The Kingswood ratepayers met last week to discuss the bad lighting carried out by Messrs. Parfitt, and they moved the following resolution:—"That we urge the Local Board to see Messrs. Parfitt complete their contract for the lighting of the district, as specified." Members of the Local Board are to go round the Hanham district and view the installation, as complaints have been made of the bad quality of the light. A test is to be made.

Purifying Water by Electricity.—According to a new process which has been worked out by an American, Mr. C. G. Collins, of Woodsburgh, and which is more particularly applicable to the purification of water for domestic use, manufacturing purposes, &c., oxygen gas is used in combination with the electric current. The apparatus in which the water is treated consists of a long closed tank containing a series of carbon or platinum electrodes which are connected alternately to the positive and negative poles of a dynamo, or any other convenient source of electricity. The ends of this tank are provided with water inlet and outlet taps, respectively; whilst oxygen under pressure is supplied by a pipe entering at one end and running nearly the whole length of the chamber, the portion inside the chamber being perforated to allow of the escape of the gas. Under the conditions obtaining in this apparatus, it is stated that the nascent oxygen, liberated by the electric current, combines with the oxygen introduced and dissolved in the water, forming from the very beginning a maximum amount of ozone, under the influence of which any impurities present in the water are rapidly destroyed or rendered insoluble.

Phosphorus Making by Electricity.—An invention referring chiefly to improvements in the extraction of phosphorus by electrical furnaces has recently been elaborated by Mr. T. Parker. The object is to overcome the objections arising from the condensation of this substance in the upper part of the charge of such furnaces. The improvement consists in making the upper part of the furnace a sort of retort, which is heated to retain the charge in this part at such a temperature as to prevent the condensation of the phosphorus. This process claims to economise the electrical heat in the arc of the furnace.

Lightning as a Photographer.—At Errol the other day the telephone linemen were called to repair a break. The wire had been fused by lightning, and on one of the white insulators the workmen found a distinct picture of the roof of a neighbouring house, the picture evidently having been flashed on the porcelain by the lightning.

Chicago Exhibition.—We have received from the Bubier Publishing Company, Lynn, Mass., a copy of the souvenir calendar of the World's Fair, 1893. This has been tastefully got up. On each of the sheets for the twelve months is a good illustration showing the principal buildings in connection with the exhibition.

Magnetic Matter in Meteorites.—The examination of the meteoric stone which fell not far from Riga, in April, 1890, has just been concluded. It appears to belong to the "chondrite" class of meteoric stones. The metallic portion, which amounts to 23·77 per cent. of the mass, consists of 5·82 per cent. of magnetic pyrites and 17·95 per cent. of nickeliferous iron; the remainder consists of silicates with traces of chrome iron and soluble matter. Another "chondrite," which fell at Ljungby, in Sweden, in April, 1889, was found to be particularly rich in nickeliferous iron. The well-known "Jelica" meteorite has been found to contain less than 3 per cent. of metals (Fe. Ni. Co. and a trace of Cu.). The aërolite which fell in Kansas in 1890 contained 7·7 per cent. of nickeliferous iron, whilst over 11 per cent. of nickel and cobalt has been detected in the meteorite which fell recently in Garrett Co., Maryland. It is a curious fact that these occasional visitors from the limitless regions of space invariably contain substances which exhibit to a marked degree the property of magnetism.

Experiments in the Electrolysis of Copper.—Mercury, silver, bismuth, antimony arsenic and tin are known to act disturbingly in the electrolytic separation of copper. Copper can be completely separated from ammoniacal solutions, and very expeditiously, when the solution contains fairly good conducting salts; hence it is important to know how it behaves in comparison with other metals. Silver, lead, mercury and cadmium are separated at about the same rates as copper; nickel is very slowly separated. Antimony, arsenic and tin are not separated under conditions in which a weak current is used. A method recently adopted by G. P. Drossbach is as follows: A quantity of added salt and the metallic copper were dissolved in warm nitric acid mixed with excess of ammonia (after the addition of sulphuric acid and filtration, when lead and silver were present), filtered and electrolysed. The following were the results obtained:—Experiment 1. 0·1350 gramme electrolytic copper yielded 0·1348 gramme Cu. Experiment 2. 0·1221 gramme electrolytic copper yielded 0·1220 gramme Cu. Experiment 3. 0·0620 gramme electrolytic copper yielded 0·0622 gramme Cu. Experiment 4. A sample of pyrites yielded 23·47 per cent. Cu., which by the ordinary method had given 25·53 per cent. Cu. In the experiments 1 and 2, aluminium, antimony, arsenic, chromium, iron, cobalt, manganese, uranium, bismuth, tin and zinc were present; and in experiment 3 (the result of which was obtained after the separation of the added lead and silver) silver, lead and nickel also. In experiment 3, the deposition of the copper took three hours, and in No. 2 from five to six hours. With a strong current passing for 12 hours, weighable quantities of cobalt and tin were deposited after the complete separation of the copper. These experiments showed that if nickel were present, the current must not be allowed to pass too long or it will be deposited.

The Resistance of Return Circuits on Electric Street Railway Practice.—In a communication to the New York *Electrical Engineer*, Mr. R. L. Warner gives the results of some experiments which he has made relative to this subject. The experiments prove that a very considerable reduction in the resistance of the rails is effected by a system of double bonding, and moreover, that the use of a continuous wire with each rail, in addition to single bonds, commonly recommended as "best construction," is not only much more expensive but also considerably less efficient than double bonding alone. It is pointed out that in one case, 24,480 feet of continuous wire and single and cross bonds could be replaced by 5,480 feet of double and cross bonds with the same reduction of the resistance of the track.

Bristol Electric Lighting.—About a dozen tenders have been sent in for laying the distributing mains in connection with the Bristol installation, and they range from £25,000 down to £12,000. They have been referred to Mr. Preece, the consulting electrician, to report. The work at the central station is rapidly progressing. It is, however, believed that the installation will not be complete until August.

Papers on Dissociation.—Those who are fond of following the polemics of the great dissociation controversy will find entertaining reading in a paper by M. Planck, recently published in the *Zeit. Physikal Chem.* (*vide* ix., pp. 636-637). The author upholds, against Svanté Arrhenius, his thermo-dynamical proof of the law for the lowering of the freezing point, and of the vapour pressure of solutions. Some have twitted him with pushing his claims as the original discoverer of the electrolytic dissociation theory, but he takes the opportunity in this paper of disclaiming any pretensions on his part to priority. The same journal, pp. 656—668, contains a lengthy paper by R. von Sonnenthal on dissociation in dilute solutions of the tartrates. While investigating the influence of concentration on the rotatory power of dilute solutions of certain normal and acid tartrates, he found that although the specific rotation decreases in all cases with decreasing concentration up to a certain point, a change occurs as the solutions become very dilute, and the specific rotations begin to increase slowly and regularly with further dilution. From the experimental facts which he observed, he concludes that this change is due to dissociation of the salt molecules with rising dilution.

Oil versus Air as an Insulating Medium.—As the result of a series of experiments, Mr. J. B. Williams, in a communication to the American Institute of Electrical Engineers finds :—1. That air, even when it has a humidity of 80 per cent., is infinitely superior to oil for insulating conductors carrying high tension currents. 2. That pure paraffin is far superior to oil, both for insulating conductors and for preventing the escape of the current across the surface of glass. 3. That air, having a humidity of 80 per cent., is superior to paraffin as an insulating medium. 4. That oil will not prevent leakage of the current across the surfaces of glass. 5. That whenever oil covers the surface of hard rubber, even when the latter is paraffined, it destroys the high surface insulation of the paraffined hard rubber; that is, the low surface insulation of the oil has been substituted for the higher surface insulation of the hard rubber, when used bare and clean, or when covered with paraffin. The writer also shows that there is but little difference in the specific resistance of different kinds of vegetable fibre when the fibre is clean and absolutely dry. The resistance of such fibre is high as long as it remains in this condition. But it is almost impossible to keep it so. It may be a matter of surprise to many to learn that cotton which has been dried, and which, therefore, possesses good insulating properties, loses these properties in less than 10 minutes if exposed to a damp atmosphere. Paraffined wood is very apt to be of little use in a short time, for no matter what kind of soft porous material is paraffined by allowing it to absorb the melted wax, the wax rarely hardens in a solid form, but usually contains numerous small spaces, and these spaces absorb moisture by capillary attraction. It is for this very reason that a dielectric which is formed of fibre saturated with paraffin soon loses its high insulation when exposed to the air. The microscope will demonstrate the presence of these minute air spaces.

A Steering Balloon.—It is claimed that Carl Theodor Geissler, a Hamburg gardener, has solved the problem of steering balloons. The balloon designed by this inventor resembles a torpedo, the object being to enable it to overcome more easily the resistance of the air. The balloon is not enveloped in a net, but its folds are sewn into the case, so that if a rupture occurs at any point, a rent from one fold to another is formed, and the gas escapes quite gradually. The car hangs by ropes, fastened by loops to the lower folds of the case. It is as long as the balloon itself, and has a winged screw in front and a rudder behind. The screw is driven by a Daimler's petroleum motor of aluminium, weighing only 120 kilogrammes, which makes 1,000 revolutions in a minute, and moves the balloon forward. The rise and fall can be regulated by a sliding weight, and by a ring which encircles the case, and on the surface of which the air exerts greater or less pressure, according to the horizontal or oblique position of the balloon. Although some of the arrangements have been patented, we do not think there is any advance on the experiments carried out by Captains Rénard and Krebs, of the French Army, some years ago in Paris.

What a Cable Line Can Do.—Just after six o'clock on Monday evening, as a tramcar on the cable line up Highgate Hill was ascending towards St. Joseph's Church, the gripper lost hold of the cable, and the car began to run backward down the hill. On reaching the end of the line, near the Archway Tavern, it ran into a small "dummy" car standing in front of one of the larger ones, and totally wrecked it, the runaway car being also considerably injured. The shock knocked the stationary car, behind the "dummy," off the line, and it ran away down Holloway Road for about 200 yards, causing great alarm, finally coming to a standstill in the centre of the thoroughfare near the end of Elthorne Road. No one was seriously hurt, although the streets were crowded at the time. The Board of Trade recently gave notice that the licence to run the cable tramway would not be extended beyond the present month without a further careful inspection.

Solubility Experiments and Electrolytic Dissociation.—According to the principles which have been laid down by Nernst, and from time to time noticed in these pages, it is possible, from experiments on the solubility of a sparingly soluble salt in aqueous solutions of another salt containing one ion in common with it, to calculate the degree of dissociation of the one salt, provided that that of the other is known. Bearing these principles in mind, which, by the way, are collected in the *Zeit. Physikal Chem.*, iv., p. 372, A. A. Noyes, who has already distinguished himself in this department of research, has made an investigation, in which he has taken, as his standard substance, thallous chloride—a substance which he assumes to be equally dissociated with the chlorides of the alkali metals in equally strong solutions. Proceeding from this basis, he has calculated, from the results of experiments on solubility, the degree of dissociation for a large number of salts. His results are to be found in detail in the *Zeit. Physikal. Chem.*, ix., pp. 603—632. They seem to be by no means in accordance with those which have been derived from a consideration of the electrical conductivity of the salt solutions, and he illustrates this by a table, in which are shown, side by side, the values derived from conductivity, and those from solubility, in a number of instances. He also finds that the chlorides of the alkali metals are equally dissociated, whilst the chlorides of magnesium, barium, calcium, manganese, zinc, and cupric chloride are also nearly equally dissociated, the degree of dissociation being slightly less than in the case of the alkali chlorides. Cadmium chloride is much less dissociated than these.

The Calculation of Magnetomotive Forces.—The magnetomotive force necessary to overcome the magnetic resistance of a joint.—As a supplement to the article published in *L'Industrie Electrique*, February 25th, 1892, No. 4, page 82, on the rapid calculation of magnetomotive forces, and accepting as the value of the magnetic resistance of a joint the figures found by Mr. Ewing (see p. 472 of the current number), we will (*L'Industrie Electrique*) calculate in ampère-turns the magnetomotive force necessary to produce a given induction, B, through this joint. This magnetomotive force, F, is evidently in proportion to the induction, and is expressed as follows :—

$$F_j = k\,B,$$

k being a constant which has for its value

$$k = 0{\cdot}8 \times {\cdot}0033 = {\cdot}0027.$$

In order to apply these values to the case of a dynamo, we must not forget that the induction is not the same in every part of the magnetic circuit; and that, consequently, the value of F varies from one joint to another. Let us take, for instance, an inductor in which we make B = 10,000. The two cores being fixed on the yoke will give two joints. For each the necessary magnetomotive force will be equal to

$$F_j = k\,B = {\cdot}0027 \times 10{,}000 = 27 \text{ ampère-turns.}$$

For the two joints 54 ampère-turns will be required. In dynamos, the joints of the inductor increase by 2 to 5 per cent., the magnetomotive force necessary to create the induction, B, in the inductors; it is therefore not to our interest to multiply them indefinitely.

La Plata Electric Tramcars.—A recent trial of electric tramcars at La Plata is said to have been a great success, there not being a hitch in the working.

Taunton Electricity Works.—Regarding the proposed purchase of the electric light works, a Board of Trade enquiry is to be held on 13th inst.

Moneymore Electric Lighting.—Moneymore, a small town in Ireland, has been hitherto lighted with oil lamps, but a Belfast paper says that a contract has been given by the corporation to a large electric light firm.

Nottingham and Electric Lighting.—The special committee have prepared a lengthy report on the electric lighting of Nottingham borough. They recommend the purchase of a site at £10,175, and expenditure of £34,580 on buildings, plant, mains, &c.

Chapel Electric Lighting.—Chagford (Devon) Bible Christian Chapel was on Wednesday last week lighted for the first time by electricity. The total lighting is equal to 96 C.P. but will probably be increased to 108 C.P.

Redruth Electric Lighting.—The proposed Electric Supply Company, Limited, for Redruth, before issuing their prospectus are making enquiries so as to estimate what support they will receive from the public as shareholders and consumers. The capital of the company will be £10,000 divided into 500 £5 shares 5 per cent. preference, and 1,500 ordinary shares of £5 each. The company propose, at first, says the *Western Morning News*, to supply the electric current at the same price as gas at 4s. 6d. per 1,000 cubic feet (light for light).

The Colour of the Ions.—The origin of colour constitutes one of the most obscure, yet fascinating subjects for research that could possibly be chosen. It has been attracting some considerable attention lately. Dr. H. E. Armstrong, whom the Germans are wont to term the "first of English chemists," has already given the scientific world several papers in which he has discussed the relation which colour bears to constitution, and quite recently he has produced another, in which he calls attention to the colour appearance in quinoline derivatives and of fluorescence in quinine salts. Meanwhile, Ostwald, whose untiring efforts in the exploration of physico-chemical fields of research are almost amazing, has just published a paper in the *Zeit. Physikal Chem.* ix., pp. 579—602, which deals with the colour of the ions. We believe Prof. Ramsay suggested a short time ago that much information might be gleaned concerning colour qualities by a systematic study of the absorption spectra, and this seems also to have been the prevailing idea in Ostwald's work. He has investigated these spectra for solutions of various series of coloured salts, measuring the position of the bands and also photographing the entire spectrum in each case. From the observations made it appears that the spectra of dilute solutions of salts with the same coloured ion are identical. For instance, the series of permanganates at a dilution of 500 litres gave numbers which for hydrogen, potassium, sodium, ammonium, lithium, barium, magnesium, aluminium, zinc, cobalt, nickel, cadmium, and copper, exhibited a close agreement. At this stage of dilution then, at which the metallic permanganates are completely dissociated, it would seem that the spectra of the solutions are identical; the photographic reproductions of the spectra of different salts shown side by side also help this view. Ostwald also examined the salts of fluoresceïn, rosin, iodocosin, dinitrofluoresceïn, orcinphthaleïn, rosolic acid, diasorcsorcin, safrosin, pararosanaline, and a number of others. The results in general were the same as those for the permanganates. It is to be hoped that other investigators will turn their energies into similar fields of research, for their seems little doubt that they will find it fruitful of result.

Bognor Electric Lighting.—The Board of Trade has notified the intention of revoking the Bognor 1890 provisional order.

Electric Light for Omnibuses.—The *Daily Chronicle* says that the London General Omnibus Company are lighting the whole of their omnibuses with electricity, and all the lines known as the "Favourites" have already been fitted.

New York Cable Companies.—A letter which is being circulated by the president of the New York Postal Telegraph-Cable Company, regarding the rumour that the Western Union Telegraph Company had purchased, or intended to purchase or control, the Postal Telegraph Cable Company. He states that no consolidation, purchase or any other arrangement, by which the Postal Telegraph-Cable Company ceases to be an absolutely independent and competing telegraph system, has been made or is contemplated.

Falmouth Lighting.—No further new gas lamps are to be purchased at Falmouth, on account of the probability of the town being lighted by electricity at an early date.

Lectures.—Mr. T. P. Treglohan, on Thursday last, lectured before the Plymouth and District Students' Association on "Frictional Electricity."

Mr. H. L. Callender, M.A., is delivering a course of lectures on "Practical Applications of Electricity" at the Plymouth Technical Schools. The lectures are illustrated by lantern slides and models.

Mr. J. L. Howard, Demonstrator in Physics at the University College, has lately delivered a course of three lectures at the Picton Lecture Hall, Liverpool, on "The Electric Light."

A series of lectures on "Electricity," illustrated by experiments, are being delivered at Bromyard by Mr. A. J. Cooper, B.Sc., &c.

The City Electric Lighting.—At the City Commissioners of Sewers, on Tuesday last, Col. Haywood, the engineer, stated that application had been made to the Gas Light and Coke Company with regard to utilising the existing lamp-posts in side streets for incandescent lights in such a way that if the electric light should fail the gas would still be available. The company had replied, pointing out the difficulties under which they were at present carrying on the street lighting. They could not allow their fittings to remain as suggested, but they proposed, as soon as the lamp-posts were utilised for the electric light, to vacate them altogether. Colonel Haywood said that was a most important matter for the commission. There would be no alternative supply in case the electric light should fail. The gas company's letter was referred to the Streets Committee.

The Inventor of the Dynamo.—In the *Times* of yesterday, Messrs. Abel and Imray, the patent agents, urge that the late Dr. Werner von Siemens was practically—whatever meaning that expression may have to them—the first inventor of the dynamo, because early in 1867 he communicated the invention to his brother, who patented it here on January 31st, 1867. Messrs. Abel and Imray admit Varley's prior specification, but as this was only provisional, they claim for Dr. Werner von Siemens the credit of first making the invention known to the world, and putting it into practical shape. What motive may have influenced the writers we cannot say, but surely patent law does not deny priority of invention to a man who patented the dynamo, and actually constructed the first machine in 1866—the previous year—because his specification was only provisional? Messrs. Abel and Imray do more harm than good to the memory of a great man by using such arguments as these, for the history of the invention of the dynamo—and the part played by Wheatstone, who they considerately ignore altogether—is perfectly well known in electrical circles.

St. Helens Electric Lighting.—A committee has been formed to consider the question of suppling electricity within the borough.

Ashton and Electric Lighting.—The electric lighting of Ashton public buildings and baths has been very successful, and we now learn that steps are to be taken to arrange for the electric lighting of the whole district.

Coast Communication.—Mr. W. H. Preece, F.R.S., Engineer-in-Chief and Electrician to the General Post Office, has been appointed a member of the Royal Commission on Electrical Communication with Lighthouses, &c., in the place of Mr. Edward Graves, deceased. A meeting of the commission was to be held yesterday, when their first report was to be considered.

West Bromwich Electric Lighting.—The West Bromwich Estates Committee of the Corporation have considered a scheme for the lighting of the Town Hall, offices, the institute, and the free library buildings by electricity. The estimated cost is about £1,750.

Chelsea Lighting.—A report on the lighting of Chelsea main roads has been prepared by the surveyor, Mr. T. W. E. Higgens. It has been referred to the General Purposes Committee with recommendation to the surveyor to bear in mind the probability of something being done in electric lighting ere long.

The O.S.A.—The next O.S.A. smoking concert will take place at the Broad Street Station restaurant on Friday evening, 16th inst. The programme is said to be an unusually good one.

Newmarket Electric Lighting.—Plans for laying down electric light apparatus and supply in Newmarket have been considered by the Local Board, and they have asked the electric lighting company to consider the question of putting wires underground instead of overhead.

Derry Electric Lighting.—Some of the Derry ratepayers are sternly protesting against allowing the corporation to borrow £40,000 for electric lighting purposes, and they have resolved to oppose the application when made to the Local Government Board.

Dudley and Electric Lighting.—Arrangements with the gas company at Dudley not being satisfactory, the Borough Surveyor is obtaining particulars regarding electric lighting.

Wrexham Electric Lighting. — The Wrexham Town Council have reopened negotiations with the Wrexham and District Electric Supply Company, Limited, with a view to purchasing their undertaking.

Stafford and Electric Lighting.—The Electric Light Committee recommend that active steps be taken to have an installation of 3,000 lights, at a cost of £20,000. The County Council, Post Office, and private consumers will want 1,500 lights.

Fire Risks and Electric Lighting.—The letter which Mr. Low, of the Pacific Insurance Union, has sent to every electric lighting station under its jurisdiction, may prove of some use to the inspectors of fire offices in this country. It is published on page 689.

Varley Testimonial.—We beg to call attention to the letter in our correspondence columns, signed by Messrs. Augustus Stroh and R. E. Crompton. If the subscriptions to this fund do not reach a very substantial figure, it will be little short of a national disgrace.

Galvanometers on Shipboard.—The article by Mr. Sullivan on page 688 will be read by all cable men, from Lord Kelvin downwards, with much interest, and possibly the inventor of the "Marine" may be induced to add something to the very limited published information on this topic.

Society of Arts.—On Wednesday, December 14th, at 8 p.m., a paper on "The Utilisation of Niagara," will be read by Prof. George Forbes, F.R.S. Sir Richard Webster, Q.C., M.P., will preside.

Cheltenham and Electric Lighting.—There was considerable discussion at the last meeting of the Cheltenham Town Council on the electric lighting question. A letter from the Brush Company was read, and the matter has been adjourned until the January meeting.

North-East Coast Institution of Engineers and Shipbuilders.—At the third ordinary general meeting on Wednesday next, 14th inst., a paper is to be read by Mr. J. Brentnall Duckitt on "Continuous Current Transformers." The paper will be illustrated by diagrams shown with the aid of the Oxy-hydrogen lantern.

A Remarkable Telegraphic Record.—All through the Mississippi Valley, says the *Western Electrician*, telegraph wires were down in all directions on Friday, November 18th, owing to a severe storm. Reports from towns in Iowa and the North West were received in the Chicago offices by mail. The rush of accumulated business on Saturday, when the wires were brought up again, was the cause of a remarkable record in the Postal Office. One operator, E. D. Williams, handled 326 messages from Minneapolis in three hours and fifty minutes. This is an average of one message for every 42·3 second—a record that is believed to stand unequalled.

Antimony in Electrolytic Copper.—All the samples of electrolytic copper recently examined by Mr. W. Hampe were found to contain small quantities of antimony, varying from 0·007 to 0·020 per cent. It would thus seem as though these two metals were simultaneously deposited. In order to determine whether this conclusion is a sound one, Mr. Hampe has been conducting a series of laboratory experiments. A sample of copper sulphate, containing 25·09 per cent. of copper and 0·0083 per cent. of antimony, was electrolysed, and some copper was produced containing 0·007 per cent. of antimony. An alloy of copper and antimony was treated with nitric acid, and the solution and residue thus obtained were evaporated together with concentrated sulphuric acid until fuming took place; water and 20 cc. of nitric acid were now added, and the residue of antimonic acid was filtered off. When the solution was subsequently electrolysed, a specimen of copper was produced which contained 0·0198 per cent. of antimony. The original alloy contained 99·44 per cent. of copper, 0·529 per cent. of antimony, and a minute quantity of iron. It thus appears that electrolytic copper will usually contain traces of antimony if this metal be present before electrolysis; hence the word "pure" as referring to electrolytic copper should be used with caution.

The Separation of Gold by Electrolysis. — Messrs. E. F. Smith and D. L. Wallace have been continuing their experiments on electrolysis at the University of Pennsylvania, and one of their latest results refers to the electrolytic deposition of gold. A perfect separation of this metal from other metals can be effected by the electrolysis of a solution of the double cyanide. The temperature has an important bearing on the rate of deposition, and so has the presence of an excess of potassium cyanide. If traces of arsenic are present, and also an excess of potassium cyanide, they are deposited along with the gold. The current employed was capable of liberating from 1·8 to 2 cc. of mixed oxygen and hydrogen per minute. These experiments, when concluded, may possibly be found to have some bearing on the commercial extraction of gold by electrolysis.

Action of Electric Light on Plants.—A correspondent writing to *Science*, says :—"In various reports of the effects of electric light upon the growth of plants I have noticed nothing upon the, to me, interesting question of whether the effect of electric light is to keep open at night flowers like the the lily and evening primrose, which ordinarily close at departure of daylight?"

Electric Light Safety.—We learn on unimpeachable authority, that notwithstanding the thousands of electric light installations carried out during the past 11 years, not one shilling has been paid by the Phœnix Fire Office as compensation for fire on any work passed by their inspector or which has been carried out strictly in accordance with their rules. There seems to be an uncomfortable feeling showing itself just now amongst the public, but this statement should set at rest any doubts regarding fire risks when the work is properly done by responsible contractors.

NEW COMPANIES REGISTERED.

Edison-Bell Phonograph Corporation, Limited.—This company was registered on the 30th ult., with a capital of £60,000, divided into 12,000 shares of £5 each, to enter into and carry into effect a certain specified agreement, and to apply for, obtain, or otherwise acquire any inventions, letters patent, &c., for or in relation to phonographs and graphophones, telephones, or any combinations thereof, and to the recording and reproduction of speech and other sounds; and to carry on the business of electricians, electrical, mechanical, metallurgical, and chemical engineers. The subscribers (with one share each) are:—W. Alex. Smith, Glasgow, merchant; J. Faithful Begg, Bartholomew, E.C., stockbroker; C. A. Hansom, 49, Holland Park, W., stockbroker; D. J. Smith, Glasgow, accountant; L. H. Sands, Nottingham, gentleman; E. F. Coates, 99, Gresham Street, E.C., stockbroker; C. Morrison, 53, Coleman Street, E.C., no occupation. The number of directors is not to be less than three nor more than eight; qualification, £1,000; remuneration, £1,000 out of the net profits of the company, and 5 per cent. of the net profits distributed amongst the members of the company. Registered by Messrs. Ashurst, Morris, Crisp & Co., 17, Throgmorton Avenue, E.C.

Landore Copper Company, Limited.—Capital, £3,000, divided into 3,000 shares of £1 each, to purchase and carry on certain copper smelting and manufacturing works at Landore, Swansea, now being carried on by Mr. T. Elford, of Swansea; and to carry on in all branches the trades or businesses of miners, merchants, smelters, founders, refiners, and manufacturers of copper, lead, gold, silver, spelter, iron, sulphuric acid, and other metals and chemicals. The subscribers (with one share each) are:—Thos. Elford, Landore Copper Works, Swansea; J. Harris Sanders, Shenley, Herts, merchant; W. Watson, Stamford Hill, N., manufacturer; C. T. Pannell, Stoke Newington, N., clerk; H. W. Groves, Whitehall, S.W., clerk; C. M. Sanders, Richmond, clerk; J. N. Haynes, Hornsey, N., clerk. The board is to consist of such managers as a general meeting shall from time to time determine, and the qualification is to be £300. Mr. T. Elford, J. H. Sanders, and W. Watson, are to be the first managers of the company. Registered on the 3rd inst. by Wilson, Bristow & Carpmail, 1, Copthall Buildings, E.C.

The Drosophore Company, Limited.—Capital, £15,000 divided into 3,000 shares of £5 each, to adopt and carry into effect, with or without modification, a certain agreement, and to carry on in the United Kingdom or elsewhere, the trade or business of mechanical engineers and machinists, and manufacturers and vendors of and dealers in all or any kind of apparatus or fittings used, or which may be used, for ventilating, warming, cooling, drying, moistening, or disinfecting the atmosphere. The subscribers (with one share each) are: J. McQueen, engineer, Brooklands, Cheshire; C. V. Howarth, engineer, Oldham, Lancashire; Ollo Hoffmann, engineer, Manchester; R. Hunt, mill manager, Blackburn; P. Snell, hotel proprietor, Alderley Edge, Cheshire; J. Porter, merchant, 19, Booth Street, S.W.; A. Hannier, agent, 14, St. Anne's Square, Manchester. The number of directors is not to be less than three nor more than five; qualification, 50 shares; remuneration, £100 each per annum. Registered on the 3rd inst. by C. H. Hodges, Carey Street, W.C. Registered office: 22 and 23, Arcade Chambers, St. Mary's Gate, Manchester.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Monte Video Telephone Company, Limited.—The annual return of this company, made up to the 14th inst., shows that the nominal capital of £180,000, was raised in 1889 to £220,000. There has been 3,000 ordinary and 3,000 preferred shares considered as fully paid up, and these were allotted to the vendors in consideration for premises and property. Upon the remaining 25,000 preference and 12,000 ordinary shares the full amounts have been called, resulting in the payment of £185,000.

Sheffield Electric Light and Power Company, Limited.—The statutory return of this company, made up to the 15th inst., shows that out of a nominal capital of £98,000, divided into 14,000 shares of £7 each, 3,999 shares have been taken up, and £5 has been considered as paid on this number of shares. The total amount agreed to be considered as paid on 3,999 shares reach £19,995.

Pacific and European Telegraph Co., Limited.—At an extraordinary meeting of this company, held at Winchester House, Old Broad Street, E.C., on October 19th last, it was resolved that "The share qualification of a director, as provided by Article 59, shall not apply to Sir John Pender, G.C.M.G., M.P., who may at any time hold the office of, and act as director, without being the holder of any shares in the company."

Ipswich Electricity Company, Limited.—The annual return of this company, lately filed at Somerset House, shows that out of a nominal capital of £100, divided into 100 shares of £1 each, seven shares have been taken up, nothing having as yet been called.

United Asbestos Company, Limited.—The annual return of this company, filed on October 17th, shows that out of a nominal capital of £110,000, divided into 1,000 preference of £10 each, 10,000 ordinary, and 10,000 deferred shares, both of £5 each; 9,975 "A" ordinary, 9,975 "B" deferred, and 997 shares have been taken up. There has been £5 called up on each of the "A" shares, and £10 on the preference. The total amount of calls received reaches £59,945.

Wyndham Electric Light Company, Limited.—The annual return of this company shows that out of a nominal capital of £1,500, divided into 1,500 shares of £1 each, 883 shares have been taken up. There has been 15s. called on each of 483 shares, and the total amount of calls received reaches £362 5s. There are no calls unpaid.

Yorkshire House-to-House Electricity Company, Limited.—The annual return of this company, filed on March 16th last, shows that out of a nominal capital of £100,000, divided into 19,900 ordinary, and 100 founders' shares of £5 each, 107 shares have been taken up; but that nothing has been called upon any one of those shares.

CONTRACTS OPEN AND CLOSED.

OPEN.

Blackpool.—December 14th. For the erection of a central electric lighting station for the Blackpool Town Council. Further particulars from Mr. J. Wolstenholme, borough engineer Town Hall, Blackpool.

Blackpool.—December 14th. For the supply of 440 yards 7-inch, 2,000 yards 4-inch, and 9,300 yards 3-inch cast-iron pipes with turned and bored joints, coated with Dr. Smith's compound, weight 33, 51, and 85 lbs. per yard respectively, for the electric light mains. Further particulars from Mr. John Hesketh, borough electrical engineer, Central Store Yard, Blackpool.

Brescia.—January 31st. The date for the receipt of tenders invited by the municipal authorities of Brescia, for the electric lighting of the town, has been extended to January 31st.

London.—December 12th. For the supply of 100 ornamental lamp columns, for the Vestry of St. Mary, Islington. Further particulars from Mr. Wm. F. Dewey, Vestry Clerk, Upper Street, Islington, N.

Germany.—December 13th. The Material Bureau of the Prussian State Railways, at Bromberg, is inviting tenders until December 13th for the telegraph supplies required during the financial year 1893-94. Amongst the items required are 172 metrical tons of galvanised iron wire, 10 metrical tons of galvanised steel wire, 3,740 telegraph poles, paper bands for Morse instruments, and porcelain insulators.

Portsmouth.—January 5th. For the supply and erection of boilers, engines, electrical machinery, apparatus, &c. Further particulars among our advertisements.

Roumania.—January 10th. The civil authorities of Turn-Severin, Roumania, are inviting tenders until January 10th, 1893, for the electric lighting of the town.

Swindon.—December 12th. For the supply of electric light for one year (1893) for the Swindon New Town Local Board. Further particulars from Mr. H. Kinnair, clerk, New Swindon Local Board Offices.

CLOSED.

Worcester.—The Worcester Council have entered into a contract with the Brush Electrical Engineering Company for carrying out the electric lighting of the city at a sum not exceeding £23,109.

BUSINESS NOTICES, &c.

The Electric Lighting of Rotterdam.—At the request of the administration of the town, tenders were recently invited from electrical firms for the construction of a central station for the account of the town for the supply of electric light, and for the furnishing of electric power, particularly for the operation of the cranes on the Feyenvord. The following eight tenders were submitted:—

	Gulden.
Société anonyme pour la transmission de la force par l'electricité, Paris	649,000
Compagnie Continentale Edison, Paris	700,000
Thomson-Houston International Electric Company —European representative in Hamburg ...	562,000
Crompton & Co., London	520,000
Schuckert & Co., Nurnberg	445,000
Siemens & Halske, Berlin, Plan 1*a*	413,000
" " Plan 1*b*	360,000
" " Plan 2	313,000

The directors of public works, to whom the tenders were sent, recommend unanimously that the second project submitted by Messrs. Siemens & Halske should be adopted and carried out. The station would at first supply current for 3,500 incandescent lamps, for the operation of eight cranes during the daytime, and for the working of the great iron bridge over the Maas. Provision is, however, made for an extension of the plant to energise 6,000 glow lamps, and to actuate 15 cranes. With a few alterations, the cost of the initial station would amount to £32,985, whilst the expenditure for the larger output of 6,000 lamps, 15 cranes, &c., would come to £83,500. A decision on the subject will be arrived at on the occasion of the next meeting of the Municipal Council.

The Electric Light in the City.—Much new work has lately been taken in hand in the City. Messrs. J. & C. Christie, of Mansel Street, Aldgate, are engaged on a contract at 14, Billiter Street.—In the premises of the London Shipping Exchange in Billiter Street, electric lighting is being carried out by Messrs. Pritchett Bros., of 39, Soho Square, W.—Messrs. E. L. Berry Harrison & Co. are at work in the premises of the Traveller's Accident Insurance Company, Limited, 9, Gracechurch Street, E.C.—Messrs. Laing, Wharton & Down are fitting up 108, Fenchurch Street.—Messrs. Sharp & Kent are fitting up 110, Cannon Street.—Messrs. H. F. Joel & Co. are fitting up St. Benet Chambers, Fenchurch Street.—Work has recently been completed in the premises of Mr. John A. Colding, 47, Fleet Street, E.C.—Electric lighting work is also being carried out in the London offices of the Unbreakable Pulley and Mill Gearing Company, Limited, Cannon Street, by Messrs. Barclay & Son, of Regent Street, W.—Messrs. Barclay and Son, of 138, Regent Street, and 359, Oxford Street, W., have recently completed an electric installation at the offices of the Bovril Company in Farringdon Street, E.C.

The Electric Light in the West End.—A large number of new electric lighting contracts have been taken in hand in this district, among which we may mention that Mr. Harry South, of Garrick Street, S.W., has the order for the whole of the electric lighting arrangements in the new Oxford Music Hall, Oxford Street.—Messrs. Meteyard and Haine, of Archer Street, Bayswater, are fitting up the premises of the Art Union of London in the Strand.—Messrs. Vaughan and Brown, of Kirby Street, E.C., have recently completed electric lighting work in the premises of the "Flying Horse" Hotel, Oxford Street, and one comprising 600 lamps in Sexton's Repository, Central Hall, Holborn.—A contract has recently been completed on the premises of L. Bonvalet, Shaftesbury Avenue.

Private Electric Lighting.—Messrs. Rashleigh Phipps and Co. are carrying out the lighting of the new and extensive premises of the Star Life Assurance Company, 32, Moorgate Street. They are also engaged upon Messrs. Elkington & Co.'s premises, 73, Cheapside, with a very large installation, also a large number of smaller contracts in the West End of London and the country.

Messrs. Pyke & Harris are carrying out the following installations:—For Lord Montague, at 91, Queen's Gate, W., and at 47, Gloucester Terrace, Hyde Park.

The following are some of the installations which Messrs. Paterson and Cooper have in hand:—Royal Mail Steamship Company's Offices; Victoria Hall, Regent Street; Baker's Hotel, Baker Street; Workman Clark's Shipbuilding Yards, Belfast; four shops for Messrs. Lipton, in Glasgow; the Eastern Club, Dundee; Northern Assurance Company's Office, Dundee; the Corporation Markets at Hull; the ss. *Longships*, for the Clyde Shipping Company; the ss. *Princess Beatrice*, for Messrs. Langlands; the ss. *Polynesian*, for the Allan Line; the ss. *Matin*, for Messrs. Mudie & Sons; Penbedio, the residence of H. Buddicom, Esq., in Flintshire. They have also recently completed one on the *Shaftesbury* training ship, for the London School Board.

A Brush Plant in its Native Soil.—The Electric light has dawned again upon the building which once was the Borough Road works of the Anglo-American Brush Electric Corporation. The factory is now in the possession of Messrs. Robert Hoe & Co., of London and New York, printing machine manufacturers, who have largely increased its dimensions. The installation embraces a 10-light Brush dynamo, 50 volts 10 ampères, 8 16-hour double-carbon Brush lamps and 18 incandescent lamps in parallel. The latter are arranged in four sections with two mains, and take the place of two arc lamps. A three-way switch is used to control them. The dynamo takes 10 H.P. from a 60 H.P. (nominal) Galloway fixed horizontal engine, and is run off counter-shafting supplied by the contractor. In the dynamo room are a main switch resistance and ammeter. The installation has been designed and carried out by Mr. F. W. Rayner, of 69, Milton Street, E.C.

New Catalogues.—A new catalogue has been brought out by the General Electric Company. The book deals with general electrical supplies and wiremen's sundries. As a preface are given definitions of the chief electrical terms, also a description of the company's works at Manchester, and the offices and warehouses in London. Numerous illustrations appear along with the descriptions of the various articles, and particulars as to price are given. The principal headings in the book are switchboards, switches, wall plugs, ceiling roses, cut-outs, fuses, lampholders, lamps, both arc and incandescent, projectors, carbons, hints and estimates for wiring houses, casings, electric light cables, and a number of other subjects. The catalogue will, we believe, be very useful to the General Electric Company's customers.

The Electric Light at Deptford and Greenwich.—Since our last visit to these districts the adoption of the electric light has made steady progress. Among the work at present in hand, or recently completed, we may mention that an installation comprising 200 lights is being carried out in the Deptford Flour Mills of Messrs. J. & H. Robinson, by Messrs. Christy Brothers, of Chelmsford.—A contract has recently been carried out in the premises of Mr. T. J. Peckett, 212, High Street, Deptford; electric lighting work in the premises of Messrs. Spurgeon, 127, High Street; in the "Duke of Cambridge" Hotel, High Street; in the premises of Messrs. Crook, 57, High Street; at 37, Broadway; also in the premises of the Southern Drug Company, Limited, Broadway.

Tenders for Lighting Claybury Asylum.—The following tenders have been received by the London County Council for the electric lighting (contract No. 2) of Claybury Asylum:—Bourne and Grant, £14,400; J. D. F. Andrews & Co., £12,560; Fowler, Lancaster & Co., Limited, £11,780; H. Binks & Co., £10,999 10s.; Electrical Supplies, &c., Company, Limited, £10,300: R. Dawson, £9,887; Mather & Platt, Limited, £9,118 17s. 9d.; Cox-Walkers, £8,920 7s. 6d.; R. H. Barnett & Co., £8,214; F. Geere Howard, £8,076; Brush Electrical Engineering Company, Limited, £7,814; Edmundsons, Limited, £7,560; Latimer Clark, Muirhead & Co., Limited, £7,407; E. Mann, £6,491; New & Mayne, £6,278; Appleton, Burbey & Williamson, £6,074. But why such an extraordinary difference in the prices?

Change of Address.—Messrs. Gwynne & Co. have removed from their late works, Essex Street, Strand, and Victoria Embankment, where they have been established since 1852, to much larger premises in Brooke Street, Holborn, E.C. The new works are very central and convenient, and will be fitted with the most modern and improved machinery, specially suited to the requirements of the business.

The Telephone System at Lye.—A representative of the Worcester *County Express* recently visited the National Telephone Company's Exchange at Lye, where he had an interview with Mr. Johnson, the local manager, who explained the working of the system to him. Our contemporary gives a very interesting and glowing account of the telephone in that part of the country.

Auction Sale.—On 13th inst. Messrs. Wheatley Kirk and Co., will sell by auction the entire contents of the East Down Electrical Works, Lewisham, S.E., until recently the property of Messrs. A. B. Gill & Co. There is a large quantity of engineering and electrical fixed and loose plant, dynamos, motors, &c. The sale will take place on the works premises.

Mine Electric Lighting in South America.—Messrs. Appleton, Burbey & Williamson have secured the order for complete electric plant and material for the Lagunas Syndicate Nitrate Mines in South America. The plant comprises engine, duplicate dynamo for 200 incandescent lamps and some arc lamps, with switchboard and instruments complete.

Epstein Accumulators.—Epstein batteries have this week been installed at Messrs. Davis & Timmins's factory, at 34A, York Road, King's Cross, which has recently been extended, also a battery has been installed at the premises of Messrs. J. H. Ladd and Co., 116, Queen Victoria Street, E.C., in connection with the Scott-Sisling system.

Club Electric Lighting.—We understand that the electric light fittings, which caused so much comment at the opening of the Junior Constitutional Club's new palatial premises in Piccadilly, last Friday, were specially designed and manufactured by Mr. Roger Dawson, of 53, Berners Street, W.

Dundee Electric Lighting.—Last week the first of the boilers being constructed by Messrs. Whyte & Cooper, for the electric lighting station, underwent a test in their works in East Dock Street, Dundee. A most satisfactory result was obtained.

CITY NOTES.

National Electric Supply Company, Limited.

AN ordinary general meeting of shareholders in this company was held recently in a room adjoining the registered offices of the company, 119A, Fishergate, Preston. Mr. C. H. Cobbold presided.

The CHAIRMAN moved the adoption of the report and statement of accounts, as certified to September 30th. The report gave an interesting *resumé* of the company's operations in Preston up to the present. The machinery ordered, and in progress of manufacture, will form a first instalment, with a capacity of 20,000 8-candle-power lights. It is estimated that, with the day and night service, the company will be enabled to fix at least 35,000 8-candle-power lamps with this plant. Six miles of underground mains have been laid. A first-class central station in Bushell Street has been secured. It is to be thoroughly well equipped, and will be capable of supplying current to meet largely increased requirements at a small additional outlay. The expenditure on capital account amounts to £36,835. 8,045 ordinary shares have been subscribed for, and since the accounts were made up, applications have been received for 2,380 additional shares. When these are fully paid, the share capital, including founders' shares, will be brought up to £52,625. As regards future prospects, the directors consider they could not be more encouraging, there being an immediate prospect of remunerative business. The report of the manager and engineer, Mr. Bennett, went to show that, assuming the present rate of progress to continue, the result of the working for the three months ending December 31st, will show a substantial profit.

The motion was seconded by Councillor MARGERISON, who took the opportunity of complimenting the directors on the admirable way in which they had conducted the company's affairs. At the same time he congratulated the shareholders on the bright prospects before them.

No questions were asked, and the report and accounts were unanimously adopted.

Mr. E. H. BOOTH moved, and Mr. HENRY CURWEN seconded the re-election of Messrs. Titus Thorp and Ainsworth as auditors.

In accordance with a recommendation of the board, Mr. John Booth, of Preston, merchant, was appointed a director in place of Mr. Dan Rylands, of Barnsley, who retired on account of his many engagements elsewhere, and his inability to give the necessary time to the duties of this office.

The CHAIRMAN, referring to the retirement of Mr. Rylands, said although that gentleman had a very heavy stake in the concern, he had absolute confidence in the ability of the local men to manage the company's affairs.

Mr. F. F. BENNETT, the engineer, also said a few words as to the prospects of the company, and the meeting concluded with a cordial vote of thanks to the chairman.

The Morecambe Electric Light and Power Company, Limited.

THE report of the directors reads as follows:—"The directors have pleasure in congratulating the shareholders on the successful establishment of the company's installation, and its profitable working, as indicated by balance-sheet. They believe the company's position, in the latter respect, to be exceptional. The consent of the Board of Trade to proceed with works was only given March 12th, 1892, greatly limiting the time in which to get down the plant for season business. Notwithstanding, cables were laid in 13 streets, and the work so efficiently done so as to preclude any appreciable leakage. The demand for service being much in excess of the provision made (which was based on the subscribed capital), the directors found it requisite to make considerable additions to the generating plant forthwith; and as the season advanced a full-load was obtained. The directors desire to point out that these additions are not yet covered by subscribed capital, and will continue to absorb a portion of the profits which would otherwise be available for increased dividend. Now that the soundness and profitable character of the undertaking is demonstrated, shareholders should have no hesitation in availing themselves (whilst they may) of the opportunity of adding to their holding at par. As to depreciation. A considerable portion of the plant is under guarantee for first year; and the "Dowson" gas-making apparatus, and necessary building, were only completed in October. For the remainder of plant, in view of the short term of use, the item would be inappreciable, and is therefore waived. A sum of £16 3s. is, however, written off formation expenses, which stand at a low figure. The gross profit, £74 9s. 11d., is reduced by £22 6s. 7d. for interest on borrowed capital, leaving a balance of £50 12s., which the directors recommend to be applied to the payment of a dividend after the rate of 5 per cent. per annum on the "called up" paid share capital. Shareholders will be pleased to learn that important extensions of the service are now in progress, and others intended to be carried out in the spring. The retiring director (Mr. Farrar) is eligible, and offers himself for re-election, The auditor (Mr. Duff) also offers himself for re-appointment.

The Place Clichy Electric Lighting Company.

THE usual general meeting of this company was held on October 20th, 1892. The report presented by the directors was as follows:—

The second year's service, of which we give you an account to-day, and which comprises the period from July 1st, 1891, to June 30th, 1892, has been very satisfactory, fulfilling the highest expectations. You remember that by June 30th, 1891, we had subscriptions for 16,979 lamps, out of which 9,517 lamps were in use. By June 30th, 1892, we had subscriptions for 35,286 lamps, and 29,522 lamps in service.

These figures have increased since then, and will continue to do so for many years, as we have an immense field before us, especially as regards private consumers. The latter, in fact, see, with as much astonishment as satisfaction, that besides the marvellous light, our system of lighting by meter is more economical for them than oil or candles. The length of our canalisations is continually increasing. At present it exceeds 33 kilometres, including:—

Feeders or primary cables	35,710	metres.
Distributing or secondary cables ...	153,952	„
Cables for public lighting	6,361	„
Total	196,023	„

Or an average of six cables in each main.

This extension of the system, and the necessity of being ready to meet the fresh applications that are daily being made, have obliged us to order two new boilers, a large 500 horse-power engine with its dynamo and various accessories. We have also had to order a large battery of accumulators, which will enable us always to have at hand a powerful reserve of electricity, and effect further saving in our operations.

But it will easily be understood that these additions have increased and will still further increase, our first expenses.

On consulting the balance-sheet for June 30th, 1892, which we have the honour to submit now to your approval, you will see that these expenses have increased during this season as follows:—

Building expenses and cost of first establishment ...	879,303.35	fr.
Plant	4,764.40	„
Apparatus for public lighting...	2,724.10	„
Branch lines	157,420.75	„
Meters	45,413.35	„
Regulating stations	91,813.20	„
Total	1,181,439.15	fr.

We reckon that in 1892-3 we shall again have to spend a million francs, and we think that after that our installation will be sufficiently complete to meet the requirements of our consumers for several years.

If the season 1891-2, of which we are giving an account to-day, has been extremely satisfactory as regards extension of business, you will see, on consulting our profit and loss account, that it has also been a very profitable one.

BALANCE-SHEET *for June 30th*, 1892.

EXPENSES.

Building and first establishment expenses	5,167,155.20	fr.
Plant	91,379.65	„
Public lighting apparatus	17,108.85	„
Branch lines	258,780.20	„
Meters	78,603.35	„
Regulating stations	231,666.80	„
Rue Nollet	7,536.85	„
Stock, according to inventory...	146,016.15	„
Securities	204,599.05	„
Cash	29,862.05	„
Bankers	77,468.10	„
Various debtors...	105,953.60	„
Total	6,416,129.85	fr

FUNDS.

Capital		3,000,000.00 fr.
Bonds	3,000,000	
Bonds not issued	991,000	
		2,009,000.00 „
Various creditors		1,189,625.25 „
Bond coupon, No. 2		115.00 „
„ „ No. 3		253.00 „
„ „ No. 4		58,500.00 „
Profit and loss account...		178,636.60 „
Total		6,416,129.85 fr.

PROFIT AND LOSS ACCOUNT

Dr.

Expenses of working	326,273.40 fr.
Expenses of the directors for the season 1891-2 ...	10,500.00 „
Interest on bonds	60,772.95 „
Interest due to various shareholders	55,142.60 „
Loss account for 1891	20,647.40 „
Credit account	178,636.60 „
Total	651,972.95 fr.

Cr.

Receipts from working	651,972.95 fr.

The nine months of the first season of 1890-1 had left us, as is always the case with a first season, with a loss of 20,647.40 fr. This year we have not only been able to redeem this loss, but also to show a supplementary profit of 178,636.60 fr. From this sum we must deduct 985.70 fr. to discharge in full the amount due to M. Fournier, in virtue of the contract made with him March 1st, 1889. Thus there remains to be credited to the profit and loss account a sum of 177,650.90 fr., the employment of which is to be regulated by you.

In accordance with Article 31 of the Statutes, we have to deduct from this, with the legal reservation, 5 per cent. of the profits or 8,882.55 fr., and there remains 168,768.55 fr.

We must then endow the sinking fund according to Article 51 of the Statutes, which runs as follows:—

A sufficient sum is to be set aside annually to redeem in 16 years, from July 1st, 1891, the capital of the shares. This sum will be paid each year into a sinking fund, the use of which will be decided by the board of directors upon the proposals of the executive committee.

This article does not state whether the annuity is to be always the same, or whether the sum paid into the sinking fund may be progressive, or vary according to the profits.

In the former case we should have to pay into the sinking fund the 16th of 3 millions or 187,500 francs, which would absorb the whole of the profits. There would be no dividend to distribute. If we adopt the second course, you could take into account the fact that the company is still in its infancy, and that the future is full of promise.

The text of Article 51 being so ambiguous, and there being a desire with a certain number to receive a dividend of at least 4 per cent., your executive committee has thought it best to leave the question to be decided by the board.

Thus, gentlemen, you have to choose between the two following resolutions:—

(*a*) The payment into the sinking fund of ...	168,768.35 fr.
(*b*) „ „ „ „ ...	48,768.35 „
And the distribution of a dividend of 4 per cent or	120,000.00 „

You have also to decide upon the employment of the sums placed to the sinking fund. Your committee proposes to leave it in the cash in hand of the company.

In accordance with Articles 21 and 30 of the Statutes, you have to renew the fourth part of the members of the committee. Messrs. Jacques Siegfried and Louis Ewald are going out. These gentlemen are re-eligible.

The committee has this year experienced a great loss in the person of M. Nicolas Kœchlin, one of the most zealous and enthusiastic founders of the company. We propose, gentlemen, to appoint in his place M. Ludovic de Sinçay, of the National Discounting Bank, Paris.

The following resolutions were voted unanimously at the general meeting:—

1. The general meeting approves the report of the executive committee, and also the balance-sheet and the profit and loss account. It is decided that out of the profit 8,822.55 fr. shall be carried to the legal reserve, and 48,768.35 fr. to the credit of the sinking fund of the shares which is to be opened in the company's books; lastly, 120,000 fr. are to be distributed among the shareholders at the rate of 4 per cent., or 20 fr. per share.

2. The board decides that the sum credited to the sinking fund shall figure as a special account, entitled *Sinking Fund*, and shall form part of the company's cash in hand.

3. The meeting appoints, as members of the executive committee for a period of four years, Messrs. J. Siegfried, Louis Ewald and Ludovic de Sinçay.

4. The meeting appoints M. Geist as financial director for the season 1892-3, at the same remuneration as before.

A special general meeting was also held on October 20th, 1892. The report was presented by the executive committee as follows:—The extension of our system, and the rapidly increasing number of our customers, have obliged us to make considerable additions to our machinery, and to extend our electric cables.

This state of affairs seems to us to require an increase in our share capital. We propose to increase it by one million francs by creating 2,000 more shares at 500 fr., which would bear the numbers 6,001 to 8,000. The issuing of these shares will be undertaken by the executive committee, who will fix the time and conditions. In accordance with article 7 of our statutes, the holders of old shares will have a right of preference for 1,000 of these shares, and the holders of foundation shares for 1,000 shares. The executive committee will fix the period during which this right of preference is to be exercised.

If you approve of our proposal, we ask you to put to the vote the following resolutions:—

"The special general meeting of October 20th, 1892, after having heard the report of the executive committee, decided that: "The company's capital shall be increased by one million francs, and brought to four millions by the creation of 2,000 shares of 500 fr. each, bearing the numbers 6,001 to 8,000. The holders of old shares shall have a right of preference for 1,000 shares, and the holders of founders' shares for 1,000 shares. The executive committee will fix the date and conditions of this issue, which may be made all at once, or at different times." These resolutions were adopted unanimously.

COMPARISON OF THE MONTHLY RECEIPTS FOR THE ELECTRIC CURRENT SOLD.

	1890-1 fr.	1891-2 fr.	1892-3 fr.
July	...	19,702	28,134
August	...	25,902	30,664
September	...	31,642	42,452
October	8,948	51,666	...
November	13,765	61,629	...
December	17,763	75,685	...
January	21,878	72,059	...
February	21,072	58,617	...
March	23,456	55,567	...
April...	19,246	45,854	...
May	19,794	41,421	...
June	18,182	50,894	...
	164,704	568,638	
VARIOUS RECEIPTS.			
Laying branch lines, installing meters, &c.	5,448·45	83,334·95	
Totals	170,152·45	651,972·95	

National Telephone Company.—The directors declare interim dividends for the half-year ending October 31st, 1892, as follows:—First preference shares at the rate of 6 per cent. per annum, less income-tax; second preference shares at the rate of 6 per cent. per annum, less income-tax; third preference shares at the rate of 5 per cent. per annum, less income-tax. On 90,950 shares (£3 paid) numbered 1 to 90,950 upon the amounts paid up from the dates of the respective calls, and on 28,284 shares (£5 paid) numbered 90,951 to 119,234 from September 27th, 1892 (ordinary shares) at the rate of 5 per cent. per annum, less income-tax.

Commercial Cable Company.—This company announces a quarterly dividend of 1¾ per cent., payable January 2nd. At the meeting of the board, held on the 7th inst., it was resolved to redeem £120,000 sterling of the outstanding debenture bonds on January 15th next.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending December 4th, 1892, amounted to £947; corresponding month, 1891, £810; increase £97; total receipts to date, 1892, £18,807; corresponding period, 1891, £16,983; increase £1,824.

The Cuba Submarine Telegraph Company. The estimated traffic receipts for the month of November were £3,200; as compared with £3,263 in the corresponding month of last year.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of November, 1892, amounted to £2,137, against £2,235 in the corresponding period of last year.

The Great Northern Telegraph Company. The traffic receipts in November, 1892, amounted to £22,000. 1st January—30th November, 1892, £245,600; corresponding months, 1891, £260,000; corresponding months, 1890, £256,000.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending December 2nd, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,185.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.	Closing Quotation, December 1st.	Closing Quotation December 8th.	Business done during week ending December 8th, 1892. Highest.	Lowest.
195,100*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 —103	100—103	...	...
1,247,720*l*	Anglo-American Telegraph, Limited	Stock	50 — 51	50 — 51	50½	49⅞
2,876,140*l*	Do. do. 6 p. c. Preferred	Stock	90½— 91½	91 — 92	91⅜	91
2,876,140*l*	Do. do. Deferred	Stock	11 — 11⅜	11 — 11½	11 1/16	...
130,000	Brazilian Submarine Telegraph, Limited	10	10¾— 11¼	10⅞— 11¼	11⅛	10⅞
34,600*l*	Do. do. 5 p. c. Bonds	100	101 —104	101 —104	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	106 —110	106 —110	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3 — 3¼	3 — 3¼	3 1/16	3¼
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛— 2⅜	2⅛— 2⅜	...	...
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3 — 4	3 — 4	...	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	3 — 4	3 — 4	3 1/16	...
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	10¼— 10⅜	10¼— 10⅜	10⅜	10⅜
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	5 — 5½	5 — 5½	5⅜	5⅛
$7,716,000	Commercial Cable, Capital Stock	$100	178 —182	178 —182	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	3/16— 5/16	5/16— 7/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5¼— 5⅜	5 — 5⅛	5⅛	...
16,000	Cuba Telegraph, Limited	10	11½— 12⅛	11¼— 12⅛	11⅜	...
6,000	Do. do. 10 p. c. Preference	10	17½— 18½	17½— 18½	17⅜	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2½— 3½	2½— 3½	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅜— 11⅝	11½— 11⅝	11½	11 1/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14¾— 15	14⅞— 15	15	14¾
70,000	Do. 6 p. c. Preference	10	15¾— 16¼	15⅞— 16¼	16¼	...
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	107 —110	...	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	109 —112	109 —112	109½	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14⅞— 15⅛	14⅞— 15	15⅛	14⅞
70,600*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	104 —107	104 —107	...	...
250,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	104 —107	104 —107	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	109 —112	109 —112	110	...
122,400*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	104 —107	104 —107	106	...
163,700*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	104 —107	104 —107	...	...
300,000*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	103 —106	103 —106	103⅜	103½
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	3½— 4	3 — 3½	3 9/16	3⅜
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	3/8— 5/8	3/8— 5/8	½	...
82,395	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	1½— 1⅝	1½— 1⅝	1⅝	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	¾— 1	¾— 1	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9¾— 10	9¾— 10	10	9¾
180,042	Do. do. 6 p. c. Preference	10	14⅝— 15⅛	14⅞— 15⅛	15 1/16	14⅞
150,000	Great Northern Tel. Company of Copenhagen	10	19 — 19⅛	19¼— 19¾	19⅛	...
210,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	104 —107	104 —107	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½— 5½	4½— 5½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	8 — 9	8 — 9	...	...
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	21 — 22	21 — 22	21⅜	...
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	102 —104	102 —104	...	...
17,000	Indo-European Telegraph, Limited	25	43 — 45	43 — 45	...	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	2½— 3½	2½— 3½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	6 — 7	6 — 7	...	...
30,000	†Liverpool Electric Supply, £3 paid	5	3 7/16— 3 9/16	3 7/16— 3 9/16	...	...
10,000	Do. do. fully paid	5	5 1/16— 5 3/16	5 1/16— 5 3/16	5⅛	4⅞
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	107 —110	107 —110	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6½— 7	6½— 7	6 13/16	6⅝
50,000*l*	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	101 —104 xd	101 —104 xd	...	...
454,747	National Telephone, Limited, Nos. 1. to 438,984	5	4⅞— 5⅛	4⅞— 5⅛	5 1/16	4⅞
15,000	Do. 6 p. c. Cum., 1st Preference	10	14 — 15	14½— 15½	14 13/16	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	13⅝— 14½	13⅞— 14½	14 1/16	14
90,950	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	3½— 3⅝	3½— 3⅝	3⅝	...
726,477*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	112 —114	112 —114	113⅜	113½
48,800*l*	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	4⅜— 4⅝	4⅜— 4⅝	4⅝	4 7/16
6,318	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	5 — 6	5 — 6	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16— 5/16	3/16— 5/16	...	...
11,802	Reuter's Limited	8	7½— 8½	7½— 8½	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	7⅞— 8⅛	7⅞— 8⅛	8⅛	8⅛
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8 — 8⅛	8⅛— 8⅜	8 1/16	8⅛
3,381	Submarine Cables Trust	Cert.	116 —120	116 —120	...	...
78,949	Swan United Electric Light, Limited ... ... (£3¼ only paid)	5	3 — 3½xd	3 — 3½ xd	3 9/16	3½
37,350	Telegraph Construction and Maintenance, Limited	12	45 — 47	45 — 47	46¾	45½
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	103 —106	103 —106	...	...
58,000	United River Plate Telephone, Limited	5	2½— 3	2½— 3	2 15/16	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	90 — 100	90 — 100	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	6½— 7½	6½— 7½	...	...
260,900*l*	Do. do. do. 5 p. c. Debentures	100	100 —103	100 —103	102	...
30,000	West Coast of America Telegraph, Limited	10	2½— 3½	2½— 3½	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	103 —107	103 —107	...	...
64,242	Western and Brazilian Telegraph, Limited	15	7½— 7⅝	7 — 7½	7½	7½
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	5½— 6	5½— 5⅝	5⅝	...
33,129	Do. do. do. 5 p. c. Deferred	7½	1½— 2	1½— 1⅝	1⅝	1⅝
184,100*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	106 —109	106 —109	...	...
230,100*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	106 —109	106 —109	...	...
88,321	West India and Panama Telegraph, Limited	10	1½— 1⅝	1½— 1⅝	...	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10 — 10½	10 — 10½	10 5/16	...
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8 — 9	8 — 9	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	104 —107	104 —107	...	...
$1,536,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125	...	...
171,000*l*	Do. do. 6 p. c. Sterling Bonds	100	100 —103	100 —103	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5⅜— 6¼	5⅜— 6¼	6	5⅜

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. BANK RATE OF DISCOUNT.—3 per cent. (October 20th, 1892).

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6¼ paid) 7⅛—7⅜.—Electric and General Investment, shares of £5 (£1 paid), 2⅜—3⅛.—Founders' shares, 200—225.—Electric Construction Corporation, 6 per cent. Debentures, 95—98.—Elmore Foreign and Colonial Copper, Founders shares, 6¼—7⅛.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Founders' shares, 10—20.—Halifax and Bermuda Cable 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 2¼—3⅛.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5—5½, 1st Preference Cumulative 6 per cent., £5 (fully paid), 5¼—5⅜.—Liverpool Electric Supply Shares of £5 (fully paid), 5 1/16—5 3/16.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—⅜.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid), 10—¼.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—¼.—Do. Debentures, 103—¼.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), ⅛—¼.—£5 Preference (fully paid), 2¼—3.

LEGAL.

THE THREE-WIRE SYSTEM.

DR. JOHN HOPKINSON *v.* THE ST. JAMES'S AND PALL MALL ELECTRIC LIGHT COMPANY, LIMITED.

(*Continued from page* 668.)

NINTH DAY—NOVEMBER 25TH.

Sir HORACE DAVEY, Q.C., resumed his speech by calling attention to page 5, line 33, of the specification. "In order to combine the advantages of comparatively high potential in the feeding conductors with lower potential in the houses in which the electricity is used, I make use of a system of three conductors in combination with two dynamos coupled in series," &c. He ventured to submit that in that claim, all the patentee claimed was a series of electrical consumers arranged in series, and connected with the dynamo by the third wire from some point between the two or more mains. There was not one word about more than one series. The patentee referred to fig. 5 as an illustration in which there were more than one series; but in his letterpress he spoke only of two or more consumers arranged in series. His argument upon this point was that the patent could not be confined to incandescent lighting, for the simple reason that the patentee carefully did not so confine it, but carefully extended it to other means of lighting lamps; it could not be confined to the use of more series than one, for the simple reason that the letterpress description described only one series. Nobody had pretended that if you only had one series of incandescent lights, no benefit would be derived from the arrangement. In support of this point, the learned counsel called attention to the evidence of Prof. Kennedy, who, he said, was not cross-examined by the other side. It might be, he said, that now no one would think of putting up a system otherwise than in parallel; but it did not follow that that would have been so in 1882. He then referred to the evidence with respect to the energy saved in the Inchicore installation, and said that he was at a loss to see that it was any answer to his contention to say that the saving might have been obtained in some other way. His learned friends had notice in their particulars of the alleged anticipations at the Alexandra Palace and Inchicore; they had, therefore, ample opportunity to investigate the circumstances, as they did investigate them, with regard to the Sauchiehall case; and, as they did not give any evidence to controvert the facts which were stated by the defendants' witnesses, it must be taken that they were not in a position to dispute them. Under the circumstances he was entitled to say that the facts with regard to those installations stood admitted. Nor was there any dispute that if the defendants were right in their construction of the patent these installations were anticipations. It therefore came back to a question of construction. Supposing he were wrong in his construction of the patent; supposing his learned friends could show reason why the Court should import language into the specification which the patentee had not given, and which would confine it to an arrangement in which more than one series of lamps or consumers was used, then the question would arise, which was touched on in Prof. Kennedy's evidence, namely, whether there was any patentable invention. Supposing he had made use of the third wire in connection with electricity consumers at Inchicore or at the Alexandra Palace, could any person come to him and say, "You can get greater advantages if you use several series instead of one, and I will patent that"? He trowed not. That would not be a patentable invention. Sir Frederick Bramwell had said that all the electrical world knew how to arrange lamps in parallel, and all the electrical world knew that special advantages might be derived from having several series in parallel. That being common knowledge at the date of this patent, if it were known (as he assumed it was) that the use of the third wire was known in connection with arc lamps placed in single series, could there be any patentable invention, not for making any difference in the arrangement of the third wire, but for the use of the third wire in a manner in which it had been used, and telling the world that the number of series might be increased?

Mr. JUSTICE ROMER said it was put against the defendants on that part of the case that one of the disadvantages to be overcome, was the voiding of the brilliancy on one side or the other.

Sir HORACE DAVEY replied that that was exactly what Mr. Crompton did at the Alexandra Palace; he maintained the brilliancy—the excess of current went down the third wire, and left the arc light on the other side in its normal state. With regard to the "Andrews" evidence, he quite agreed that the evidence, taken as a whole, was not altogether satisfactory; but he was bound to say that the importance of that evidence seemed to him to be much more in its bearing upon this part of the case, than as a direct anticipation. The dynamo from Messrs. Siemens had three collector rings for the purpose of having this third wire attached, not as in a common return, but for the purpose of being used for carrying off the excessive current. Mr. Rankin Kennedy agreed that the dynamo had three collector rings, that originally the third wire was connected, that there were three wires round the room, and that Maxim lights were hung round the room; but he said that the third wire was disconnected. Which witness was to be believed? Mr. Andrews had no pecuniary or other interest in this action. It had been attempted to show that Mr. Andrews had some personal feeling in the matter because he applied to the owners of this patent for a licence. But that was only an argumentative comment of an exceedingly light character, because it did not require his Lordship's experience to see that it was wiser for a gentleman in Mr. Andrews's position to take a licence at a comparatively moderate figure than to contest a powerful company in an action. That Mr. Andrews's memory was fallible was a perfectly fair observation to make, but he could not see that there was any ground for suggesting that that gentleman's *bona fides* in this matter could be impeached. He (Sir Horace) submitted that considering Mr. Andrews's means of knowledge, and that he had sworn that he made the connection and used it continually, more credence was to be given to his evidence than to that of Mr. Rankin Kennedy, who was a casual visitor to the workshop for another purpose, and whose attention was not necessarily called by his business to the connection of the wires with the dynamo. It was remarkable that the other side, who were in possession of Mr. Rankin Kennedy's proof, never once asked McKilloch whether (as Mr. Rankin Kennedy alleged) he disconnected the third ring of the dynamo. On behalf of the plaintiff, Macfarlane had said that he did not see the third wire, but there was no reason why he should.

Mr. JUSTICE ROMER said if he remembered rightly, Mr. Andrews was the defendants' only witness who spoke positively to the third wire coming back to the dynamo.

Sir HORACE DAVEY repeated that he could not ask the Court to accept what existed at Sauchiehall Lane as a clear anticipation of the plaintiff's patent; but that there was some sort of connection of the third wire, and some sort of use for the purpose of preparing the Akester lamps he thought was undoubted. With regard to the question of publication of what was done at Sauchiehall Lane, he submitted that the fact that skilled persons were invited to come and see what was being done, and that the workmen were under no obligation of secrecy was enough, these persons being the public and able to tell the world what was being done. Lord Fry had said that the test of publication was whether any English person became acquainted with the subject matter of a patent without the obligation of secrecy. In this case it was clear from the evidence that they did. On the question of the patent being void for want of the utility in the plaintiff's regulator, he relied on the evidence of his witnesses as to the self-induced currents rendering the instrument impracticable; the statement of Sir Frederick Bramwell that the induction might be met by adjustment; and the fact that it had never been used, though no one was in a better position to push it than the patentee. In conclusion, the learned counsel submitted that the patent was bad on all the grounds he had mentioned.

Mr. MOULTON, Q.C., in replying on the whole case, said he felt one great advantage in following Sir Horace Davey, if he could not agree with the conclusion Sir Horace came to on the evidence, he had made clear what the points he raised were. In reference to the allegation that the first claim in the specification was not novel, Dr. Hopkinson was asked certain questions about a prior specification of Abdank.

Sir HORACE DAVEY said he did not open that, as it was not a strong point in the case.

Mr. MOULTON said that with regard to the first claim, the only point the defendants had raised was that it was not useful. That was the technical form of the plea. In other words, that it would not work if applied to alternating currents; or rather, the defendants said that one of the two forms mentioned by the patentee, though it would work well with direct currents would not work with alternating currents, that being the one in which the whole of the current did not go through the thick coil. All the witnesses admitted that if you took one form of the first claim and passed the whole of your current through the thick wire, it would work both with direct and alternating currents; but they said it would not work with alternating currents if you only passed a certain portion. Therefore, he had what he ventured to think was not a grave attack on the utility of the invention, namely, that in special circumstances you could choose a form so bad, if you tried to, that it would not work. With regard to the second claim, there were two points. The first was insufficiency of specification, namely, that if you took the case of alternating currents, there were not sufficient directions to enable the public to apply the invention; in other words, that the knowledge of the world in 1882 did not enable it to work two dynamos in series. There were also the objections of want of novelty by reason of certain anticipations, and want of subject matter. Those two objections ran more or less into each other. Dealing with two minor points first, How did the question stand as regarded the indicator? Dr. Hopkinson invented a machine which when feeding a network of distributing mains at a distance indicated at the station the fall of pressure at the point where the mains joined the network, thereby enabling a constant potential to be preserved. The important thing was that a workman looking at his machine might know whether his pressure was constant on the network, and Dr. Hopkinson made this instrument for the purpose of falsifying the register of pressure in his station by just so much as the pressure would fall before the electricity came into use. Therefore the workman had only just to look at his dial, and if the dial finger pointed to the proper place, which was always the same, he knew that he had got the right pressure on the place where the intensity of pressure was important. That was very ingenious and very useful. He had the authority of Lord Kelvin for saying that it was exceedingly truthful, and the authority of Mr. Bellfield for saying that a modification of this instrument had been applied all through the United States, a modification, he agreed, but then, inasmuch as the whole of the alternating supply was done on a system of transformers unknown at the date of Dr. Hopkinson's patent, there was no wonder that a modification of this instrument was necessary before it would apply to the totally altered circumstances. There was no attack on the ability of the instrument. His learned friend had cross-examined as to whether, in its primitive form, it was used. That had nothing to do with it. The very best inventions might lie unused for years. He remembered a case in about 1878 as to the vacuum brakes which automatically put themselves on in all trains now when there was an accident. It was proved that that invention which had only come

into use about three or four years, was absolutely at length described, in terms sufficiently clear and precise to enable a person to make the whole thing, in a provisional specification of the year 1851.

Mr. JUSTICE ROMER: Non-user is some evidence of want of utility.

Mr. MOULTON said that, coupled with the direct evidence of electricians that this instrument was useless, such evidence might have been important; but they had the direct evidence of the electricians they had called of its utility, and that was not contradicted, except with regard to alternating currents, by the witnesses on the other side. Dealing with the question of whether the patent was bad in law, because the instrument he was referring to was not applicable in the case of alternating currents, the learned counsel said it seemed to him that supposing the patentee did think his invention more widely applicable than it was, no duty of a patentee had been broken. Supposing a man made a novel invention of great use, and described it and claimed it, he (Mr. Moulton) failed to see why an overestimate of its powers invalidated the invention: there was no false suggestion, and no want of *bona fides* in the description of how to carry out the invention. Supposing the patentee had simply described his invention, and said nothing about these machines, the fact that it was applicable to direct currents would have abundantly supported the plea of utility. He (Mr. Moulton) knew of no case which said that a mistake on the part of the patentee as to the use of his invention which was properly described and claimed, was ground for invalidating the patent. What he relied upon here was the evidence in the case. Lord Kelvin—who was considered throughout the world our greatest electrician—and Dr. Hopkinson had told his Lordship that not only was it their opinion, but that the experiment tried in Victoria Street had put it beyond doubt that that very instrument, which was admitted to be a fair reproduction of fig. 2, could be put on to any existing supply and made to work in the manner described by the specification. What evidence on the other side could be so weighty. Lord Kelvin had actually seen it applied in a laboratory experiment, and his evidence was, that what he could succeed in doing in a small he would succeed in doing on a large scale. With regard to the second claim, he joined issue at once with his learned friend's law, that Lord Kelvin's admission that an ordinary workman might have to find out that to work the third wire with alternating currents the dynamos would have to be rigidly coupled together, was sufficient to support his plea. This patent was not directed to an ordinary workman, but to the men whose business it was to design the machinery for an installation. The ordinary workman had been made a *quasi* hero. But the defendants must show that the electrical engineers who would have to work the patent would require the plaintiff to instruct them upon the coupling of the dynamos. He (Mr. Moulton) very much doubted whether even that would be sufficient to invalidate the patent, because it seemed to him that if alternating machines had not been invented at that time, but had been invented afterwards, and this applied only to series machines, the absence of instructions as to the method of coupling the dynamo would not be fatal. The judgment of the witnesses for the defendants had been warped by their method of considering this matter.

Mr. JUSTICE ROMER: What do you say to Lord Kelvin's suggestions with regard to a common workman?

Mr. MOULTON referred to a case in the House of Lords which, apparently, laid it down that the specification must be considered as addressed to the persons who would have to carry it out; in many cases, persons of great and particular skill in the matter dealt with. Mr. Swinburne, he said, admitted that if it was thought the dynamos must keep time, it must be known that one must not lag relatively to the other; and Sir Frederick Bramwell had said that the carrying out of this was a mechanician's point, and that there were plenty of couplings which were not rigid that would do.

Mr. JUSTICE ROMER said that he did not see any way of doing it but by rigid coupling. That seemed in the plaintiff's favour.

Mr. MOULTON said the knowledge that the dynamos should not lag relatively was enough to lead to rigid coupling with regard to series or parallel arrangements; so there was no obligation on the patentee to tell the world that the dynamo should be rigidly coupled. Coming to the real substantial question—the construction of the specification—the learned counsel said he could not help thinking that Sir Horace Davey had been imitating the lion, and lashing himself into a rage with his own tail. He was glad his learned friend had made this *the* point on which he had joined battle with the plaintiff. All the witnesses for the defendants had conceded that Dr. Hopkinson was thinking of a parallel system of supply.

Mr. JUSTICE ROMER: Chiefly.

Mr. MOULTON said he thought they went further than that. They said that what Dr. Hopkinson had in his mind was the parallel system. Dr. Hopkinson might have chosen words which were too wide. He would deal with the liability with regard to that. But they all said Dr Hopkinson was thinking of the parallel system when he wrote the specification. If he (Mr. Moulton) could not put it further than that, he should start in a very favourable position before the Court, because it had always been held that, in construing the patent, that to which it was directed must be borne in mind. The whole scope of the patent had been held to be a proper case of construction. If there were terms of art in the specification, clearly he was entitled to find out for the assistance of his Lordship from those to whom the patent was directed, what the interpretation of those terms of art were. He had also a right to call in aid the background of electrical knowledge which would be in the mind of an electrical engineer who had to apply the patent, because the patent would be unintelligible to a person without that knowledge. If the specification were sufficient to a person in this position, the patentee had satisfied the necessary conditions.

Mr. JUSTICE ROMER: Now, tell me to what you say the patent is limited. I put it frankly to you that I think that is the difficulty you have to meet.

Mr. MOULTON: It is the thing I want to meet most of all.

Mr. JUSTICE ROMER: The difficulty is, the patentee has not referred to parallel as distinguished from series—not in his claim—unless you say it is a claim directly in accordance with fig. 5.

Mr. MOULTON said Sir Horace Davey's argument had been based from end to end on this: if the patentee meant parallel distribution, why on earth did he not say so? He (Mr. Moulton) said the patentee said it in the most appropriate words which even in this day he could use—said it not impliedly, but actually and specifically, in the proper language which ought to be used by an educated electrician when he was speaking of that to which it was applied. Sir Horace Davey had failed to appreciate the evidence of one of his own witnesses. He (Mr. Moulton) trusted he should show his Lordship that Dr. Hopkinson commenced by putting, as clearly as possible—far more accurately than if he had said, "This applies to a parallel system of distribution"—that to which his invention applied. The first two lines were: "My improvements principally relate to maintaining the electromotive force in a system of conductors for an electric supply at a fixed potential, but they also relate to reducing the cost of such conductors consistently with efficiency and safety." When Mr. Swinburne was cross-examined he was asked: "In the year 1882 electricians knew very well what a system of electric supply at a fixed potential was?—I say that a system of electric supply at a fixed potential was *a known phrase*. Q.: And that means that the mains at all points were at a fixed potential?—Primarily it means the translating devices were at a fixed potential; but generally it meant that the mains were" &c. Mr. Swinburne admitted that fixed potential was "a known phrase, and he (Mr. Moulton) said that that was a far more accurate phrase than parallel distribution, because if the words "parallel distribution" had been used, there might have been all sorts of questions whether it was parallel, if between the mains you put devices between the wires.

Mr. JUSTICE ROMER: The point is whether this second claim is confined to conductors at or for an electric supply at a fixed potential. Let me put this point to you. Maintaining what? The force?

Mr. MOULTON: Electromotive force is exactly the same as potential.

Mr. JUSTICE ROMER: It may mean either.

Mr. MOULTON said that the differentia of the system was that it should be a supply at a fixed potential—that could not be done without. If the sentence could be read so as to mean one or the other, he submitted that his Lordship should read it so as to support the patent. He said that no amount of torturing these words could get them to mean other than they would mean if read as maintaining the electromotive force in a system of conductors in parallel. If a man wrote a sentence which, if fairly read, had one meaning, not noticing that it might have another, it was no objection to it that it might also be made to mean something else, the Court having to construe it rather that the patent should stand than it should fall. Nobody had suggested that this language was not applicable to parallel; no person had been called to say, nor had it been suggested in argument that there was a word here which was not suitable to parallel; in fact, Sir Richard Webster had put it to Prof. Thompson whether he could point to a word in the specification which would direct a man to put it in series only, and that gentleman had answered that there was nothing whatever directing that. The point about the third-wire system was that there was no saving in branch conductors; the saving came in in the main conductors; so that when the patentee spoke of saving the cost of main conductor, that applied to the parallel, and did not apply to the series arrangement. The specification said: "For a commercial supply of electricity motors are needed." No electrician would doubt that that meant a case where the quantity of electricity varied. And if the quantity varied, therefore it was a parallel system.

Mr. JUSTICE ROMER: You say the current could not vary for a system not in parallel?

Mr. MOULTON said: No; each lamp must have its full amount, whether any others were at work or not; the current was the same whether 8 or 9 lamps were driven.

Mr. JUSTICE ROMER: I do not think it is challenged that the first diagram relates to parallel lighting only. What do you say to motors in series?

Mr. MOULTON said that if there was one single motor on each side in series there might be, then, a variation in the current. That was the only one that the defendants had been able to find out.

Mr. JUSTICE ROMER: Suppose you took motors in series with arc lamps. Could not you work with arc lamps in series?

Mr. MOULTON said: You could not work a motor on a series arc lamp current, because the motor would take varying degrees of current, and that would stop the arc lamps.

Mr. WALLACE: Unless you have the third-wire system.

Mr. MOULTON said you could then have arc lamps on one side and a motor on the other, if you wasted all the electricity, but your supply would then be on neither side at a fixed potential, it would be a different potential at every arc. Referring to page 5, line 32: "In order to combine the advantages of comparatively high potential in the feeding conductors with lower potential in the houses in which the electricity is used, I make use of a system of three conductors in combination with two dynamos in series," the learned counsel said he asked Mr. Swinburne why the patentee, in using language which admittedly referred to parallel, was to be said to include series? Mr. Swinburne admitted that the plaintiff said his system was shown diagrammatically in fig. 5, and that fig. 5 was parallel.

Mr. JUSTICE ROMER said supposing there were two houses, one on each side, and five arc lamps in each. He wanted to know whether, in that case, you would have a higher potential in the feeding conductors and a lower potential in the house?

Mr. MOULTON said that would not be a supply at constant potential at all. Standard potential meant what was maintained at all places at all times. His illustration went to the root of this argument.

Supposing they were at an infantile age of electricity, where they only knew of a single circuit, and an incandescent lamp were put on that single circuit. If a man discovered that you might have a parallel bridge, the value of that discovery would be inconceivably great, because it would give them the whole possibility of distribution. Suppose he took out a patent, and they said: "This is not good, because if we had one lamp before, and instead of many lamps you put one, you get to what we had before," that would not be a good answer. If he took an invention like that, whose advantages rested on multiplicity, it was no answer to say, "Oh! strip off the multiplicity"—the only thing of which the invention consisted—"and then you have something we had before." Keep the multiplicity there, and the invention enabled each of the lamps to be turned off independently. Independently applied not to one, but to many. It was not matter to him if the system only had one, if the system could be so arranged that you could spring from many to one, or from one to many, and have equal efficiency. The plaintiff's patent clearly pointed to many, and its whole advantage lay in that. The plaintiff said that "his system was shown diagrammatically in fig. 5." Even the witness for the defendants admitted that that was clearly confined to parallel; and Mr. Swinburne, being asked whether there was anything in the specification which would direct a man to put up a system where he would tap the mains only once, said there was no such direction. Here, then, the patentee wrote a plain specification about which there was no doubt; he never referred to tapping at one point, and he did refer to a system which tapped many times, and claimed that by specific reference to a diagram about which there was no dispute. Could it be said that when he had done that, that though he had never thought of, or referred to it, and though his claim excluded tapping at one point, his patent was to be bad because the words at the commencement of the specification, though perfectly capable of the limited meaning, could, by holding the breath in a different way, be read so as to include another meaning? He (Mr. Moulton) said that the patent related to a multiplex and independent supply arranged on the parallel system; in other words, that multiplicity was the object of the patent, that it was a system of supply where there was a potential in the mains and a potential in the houses, the former having the advantages of a comparatively higher potential, and the latter a comparatively lower one. He said both of those implied that there was throughout the system a standard potential, and if that were admitted, the plaintiff's construction of the patent was involved in the admission. In the series system there was no advantage in the comparatively higher potential. What was the advantage of the comparatively higher potential in the series? There was no advantage pointed out, because the potential varied at every point; it was simply a constant current. Neither the Alexandra Palace nor the Inchicore installations gave the advantages a higher potential arc lamps fixing their own potential.

At this point Mr. MOULTON asked his Lordship to allow him to conclude his remarks on the following Monday, in consequence of an important inspection and consultation in the country. Mr. Justice ROMER acceded to the request.

TENTH DAY—NOVEMBER 28TH.

Mr. FLETCHER MOULTON, Q.C., resuming his speech, said that he had been dealing with the construction of the claim and the specification, and he was passing from that when his Lordship called his attention to a point which had been pressed on the other side. He proposed to deal with that. The remark his Lordship made when they were engaged on the first paragraph of the specification had come back to his mind and had reminded him that there was a portion of his argument which he ought not to have omitted. Directing attention to the first paragraph, he had showed his Lordship, he thought conclusively, that arranged as you liked, even taking his learned friend's arrangement of putting "at a fixed potential" after the word "maintaining," still that could only refer to a system of conductors for an electric supply at a fixed potential, because if you were going to maintain it at a fixed potential, it must be when it was wanted to be at a fixed potential; so that there was no doubt whatever as to what that system of conductors was. His Lordship, in reading it, had put to him that "such" was rather a weak word. That made him think whether "such" would be a weak word to an electrician, and the more one thought of it, the more one felt what a tremendous amount "such" would be to an electrician in the connection in which it was used; for accepting that that first sentence only meant the conductor for supply on a parallel system, they differed to an electrician so absolutely and totally in their exigencies and in their character from conductors used under ordinary circumstances that "such conductors" would mean conductors of the most markedly distinct type. If he could show that, then he was entitled to say that a skilled electrician using the words "such conductors," would be calling up to his mind the conductors of which he was talking about, and would not mean conductors in general. The whole theory of series was you drove all your current in one way, and one way only; the whole theory of parallel was you gave the current every possible facility for taking the shortest cut to the place where it was wanted. His learned friend said it should be "maintaining at a fixed potential the electromotive force;" but the description was not maintaining it at a fixed potential in those parts which were used for supply: the whole theory was, do not maintain your potential fixed throughout your conductors, but maintain your potential in a system of conductors used for supply. In other words, comparing the sentence with the invention it described, you saw that the person had two ideas in his mind. With regard to that system of conductors which the customer had to deal with, and from which he got his supply, the patentee said that was to be a system of supply at a fixed potential, and he maintained the potential thereby sacrificing the uniformity of potential in the parts which were drawn from. The patentee wanted to keep up the supply to the customer, and the consequence was he ran it up higher than the fixed potential. He had pointed out that "such conductors" were conductors of a totally different kind. The moment you began to think of conductors for a parallel supply, you said the characteristic was that, with an ever-varying demand in quantity, the potential must not be let to fall, and therefore you wanted all your network, so that a demand from any one place might be met from different centres. There was one other phrase, consistently with efficiency and safety. Prof. Kennedy gave evidence about that, and as it seemed to him (the learned counsel), Prof. Kennedy brought forward very clearly what that efficiency and safety meant. There was the saving of copper first. Saving of copper had been proposed by means of the compound parallel, which would do the work exceedingly well, so far as the copper was concerned, but it would not do it with "efficiency and with safety." What was the meaning of doing it with efficiency and safety. Prof. Kennedy recognised the efficiency of plaintiff's arrangement, because you could turn off some of your lamps without affecting the brilliancy of the others, and you could do it with safety, because there was no danger, as in the compound parallel, of bursting your lamps. He (Mr. Moulton) could not help thinking that Dr. Hopkinson had the compound parallel in his mind when he wrote the specification, and made his invention to remedy its defects. Prof. Kennedy seemed to think that series was not excluded, but everyone admitted that the specification was directed to the parallel arrangement. One more remark with regard to tapping. He understood the difficulty to be, Why should not a single tapping be an instance of the plaintiff's system? If looked at in this way, he thought a very clear line could be drawn between one and two. He should be not very much troubled if it were more difficult to draw it, because there were cases in which the Courts had cut Gordian knots of this kind without difficulty. Would his Lordship think of the course of discovery. Some ingenious man discovered the compound parallel, but nobody knew who invented it. It obviously could have been patented. What was compound parallel? Compound parallel was this: in a parallel system put two in series, and join the middle points to one another. Suppose that had been attacked, and the anticipation had been this: "Oh, nonsense, that is not patentable, because one pair of lamps in series had been known before, and one is a case of many." The answer would have been, "Not at all; because the patentee has joined those points together, and you cannot join a point to itself." So in compound parallel there would have been no difficulty, because the joining them together required more points than one. He submitted to his Lordship that a fair definition of the three-wire system was this—join them together to the middle of the split dynamo; not only join one to the middle of the split dynamo, but join them together and to the middle of the dynamo. The joining together was as important as any portion of the invention; it was the union of the compound parallel with the divided dynamo and the wire going to it. He said that one tapping was no more an anticipation of the three-wire system than it would have been of the compound parallel, because the plaintiff's great efficiency arose from the joining together. He thought the fair definition of the three-wire system was taking the compound parallel, and removing the source of its failure, by means of the division of the source of its connection with what he might call the local clearing house wire. If that was so, the plaintiffs were right in saying that a system which must be on each set must be a system of the kind referred to in the first paragraph, namely, one in which you were dealing with equal potential, and therefore you were dealing with it in parallel, and the whole theory of the success, the whole thing at which the invention aimed, was one in which what you wanted to do was to keep uniformity of supply by uniformity of potential wherever it was, and that the system did not refer to cases where potential in the supply was not kept constant. He now came to the question of anticipation. If he were right in saying that the patent related to conductors in which there was more than one tapping, or might be more than one tapping, it was conceded neither Inchicore nor the Alexandra Palace was an anticipation. In support of this, the learned counsel referred to the cross-examination of Mr. Swinburne, from whom, he said, they had it that if the potential were fixed, unless there was only one consumer, the system must be parallel. Prof. Silvanus Thompson was asked to show the Court a system of conductors for an electric supply at various points of the main which was not on the parallel system, and the only case which he could say would not have been within those words was the one with the zigzag lines.

Mr. JUSTICE ROMER: I could not follow that, because I could not see whether it made any difference, being in zigzag or one straight line.

Mr. MOULTON said there was no difference at all, because the mains were not mains at all, but simply one circuit. The real fact was that what Prof. Thompson said was that if there was going to be a fixed potential, all the consumers having one and the same potential, then the system must be parallel, because if it was series they had it all at a different potential. Inchicore, and the Alexandra Palace Installation, did not make the plaintiff's discovery. Inchicore was used for some time. After Mr. Crompton had done the Alexandra Palace, he put up an installation in parallel, when he admitted it would have been a great advantage to him to have used the three-wire system, and he never thought of it.

Mr. JUSTICE ROMER: This is dealing with want of new invention. The best way they can put it against you is this—to say whether this is invention, you must take into consideration the Inchicore and the Alexandra Palace installations. They say, take these two installations, and tell a man to add more lamps, and he could change the series arc lamps into parallel without invention.

Mr. MOULTON said there were hundreds of people who had got near inventions, but had never made them, and he thought when you were considering subject matter, you rather had to consider the stock of public knowledge and the advance of that, &c., than to think how near a man got to it and did not succeed. The achromatic lens was

discovered by Dolland, and not by Newton. Newton was on the very edge of the discovery. All that Dolland did was to put the two glasses together. Had Newton done it with a long slit, instead of a round hole, he would have succeeded. There were cases in which a man might have made a discovery and never realised it, with the result that it passed away into forgetfulness, and the world had not got it. Dealing with the question as to whether there was subject matter in this being parallel, how did the Inchicore show you how to put in more lamps. Inchicore was a case where more lamps were put in. How? They put them in in series. None of the lamps in 1882 would burn in parallel, except the Gülcher. There was no new element introduced in passing from the Alexandra Palace to Inchicore. There was one plausible phrase of Sir Horace Davey's he wanted to deal with. Sir Horace said: "Oh, but everybody had a right to substitute any electrical appliance for the arc lights in that system." With all due respect to that very eminent counsel, he was using words there that were nonsense. Anybody has a right to do anything which has not yet been invented. There was not a question about that. They might think of doing it. It was not as though a patentee took something which everybody else had the right to take if they had been the first to take. He (Mr. Moulton) said that no one could add a second lamp in parallel without bringing in a new element which the arc lamps would have stopped them from thinking of. Inchicore represented a method of having either one long circuit, or two half circuits, according as you liked, and in the calculation with reference to the saving of copper, the witness admitted his calculation would be unchanged if, when you turned on one side, you turned off the middle. What that invention told the people was the way of having a single or double circuit with one wire, which might be useless when you had a double circuit, useful in an ordinary way when you had a single circuit. The Alexandra Palace was the same, except that it steadied lamps which would not even burn in series; but if the lamps had been put in parallel they would never have burned at all. Mr. Swinburne said that, with the exception of the Gülcher lamps, there was not one lamp known which was capable of being burned in parallel. Here they were asking whether that invention put the world in possession of the three-wire system. Why, it did not even put the men who knew it in possession of the system. Mr. Crompton subsequently put up the Birmingham Town Hall installation on the compound parallel system, which was admitted to have been imperfect. His point was, that there was nothing in the Alexandra Palace to suggest the parallel arrangement, and that there was nothing parallel in it, because if new lamps had been put on they would have been put on in series, or everything would have had to have been changed. Besides, they would not have thought of it, which was more important than all the rest.

Mr. JUSTICE ROMER did not see why the dynamos would have had to have been changed.

Mr. MOULTON said there was evidence that the very fact which made them tumble on the series system was the reversing of the dynamos, and that was the very thing which would prevent them going any further. It was enough for him to say that the lamps would not do. His main point was, that at Inchicore and the Alexandra Palace there was an absolute absence of one of the two important points, namely, the joining the intermediate points of the bridges to one another.

Mr. JUSTICE ROMER: Repeat that.

Mr. MOULTON said that one of the two essentials was absent—the joining the middle point of the bridges to one another. There were two essentials for this work; the middle point of the bridge must be joined to a split dynamo, and the middle points of all the bridges must be joined to one another. It was no use having the split dynamo joined to one bridge—you must join all the series together. There was just the same need of your intersecting network in order that you might have this middle wire supplying the want, wherever there was a want, that there was in the main conductors. All that they had was one bridge, and that joined to the dynamo; there was nothing to show that they could put on many bridges, and if they thought of putting on many bridges, there was nothing to show them that they must join them all to the dynamo. There was nothing to teach them to extend theirs so as to deal with more than one series. The thing which crushed the hopes of electricians with regard to incandescent lighting was the expense of copper, and here came an invention, which the defendants said was no invention, reducing the expense to one-third.

Mr. JUSTICE ROMER: The compound parallel had saved the copper.

Mr. MOULTON said it had in an inadmissible way. This was for a public supply, and you must have your supply efficient and safe. It was quite true that if compound parallel would have done it properly, then it would have saved the copper, but to make compound parallel keep the lamps steady and safe was impossible until you hit upon this. Dr. Hopkinson said: "I take that compound parallel and I make that efficient and safe by bringing this back and combining these two." None of the alleged anticipations before the Court *de facto* told the world that. The reason was this. The one lacked the element of bringing all these things together, and being applied to arc lamps in joining them all together was impossible; the other one had no suggestion of double dynamos at all; it simply started with the two mains, the two potentials at the dynamo; you had no possibility of a third. Neither of them invented that which solved the problem. In dealing with a question of invention, he had a right to say this: If this system could have been known to men of ability in times of need, it was clear they did not tell the public of their invention. He knew of no case where there was an absolute element of novelty in which an invention solved, for the first time, a problem which, *ex concessis*, it was desirable to solve, having been held not to be good subject matter. The effect of all the evidence was that electricians had not seen that the problem was solved at Inchicore or the Alexandra Palace. None of the witnesses showed the Court how the Inchicore or the Alexandra Palace installations would lead anybody to add the new element of a number of bridges all joined up. It did not occur to them. This was a case in which the very people called against the patent were obliged to admit a novel element, and they could not show the Court how the one would lead to the other. The defendants said, "Oh, you might substitute for the arc lamp some other appliance which would burn in parallel. Suppose you had done that, and thought of working in parallel, you would have made a parallel system." But it happened that the defendants were doing something else which did not suggest this, and the consequence was they did not make the invention. If Newton had taken another bit of glass, he probably would have invented the achromatic lens. As a matter of fact he didn't, and he did not make the invention. With regard to the Andrews point, the learned counsel said that he understood Sir Horace Davey really did not rely upon that as an anticipation, but suggested that it might cut down the patent. If that, however, were not an anticipation, it was the compound parallel. It showed them that steps which now seemed so easy that any child might take them, were regarded in the early days of the sciences as gulfs which could not be bridged over. That did not weaken a patentee's case. The egg once made to stand the process seems simple, but it is a long time before people see how to do it. As to infringement, there was no doubt.

Mr. JUSTICE ROMER: That is not in question.

Mr. MOULTON said there was one other point. In order to satisfy one of the sections of the Patent Act, one need to show that the original specification, as it was now disclosed, was drawn up with good faith and with reasonable skill and knowledge. That had not been cross-examined upon.

Mr. JUSTICE ROMER said learned counsel need not trouble about that.

Mr. MOULTON: For the reasons I have given, I submit that the case against the patent has broken down, and that the plaintiff is entitled to succeed.

Mr. JUSTICE ROMER: I am much indebted to you, Mr. Moulton, for your very able reply. I reserve judgment.

HIND v. WHITWORTH.

In the Chancery Division of the High Court, last week, before Mr. Justice Chitty, Mr. Farwell, Q.C., moved on behalf of Lady Whitworth and her co-trustees of the estate of Sir Joseph Whitworth, Bart., for an order dismissing an action as frivolous and vexatious and an abuse of the process of the Court. The statement of claim, which was of some magnitude, set out that the plaintiff, William Hind, was the surviving partner of Mr. Thomas Allen, electrician and engineer, and as such partner he claimed £1,000,000, the value of a moiety in the Dutch Concession to lay a cable between England and Holland, damages for the subornation of perjury by defendant's testator, damages for the frauds of the said testator, damages for the payment of the defendant in November, 1889, of £75,000 to Joseph Whitworth, MacGowan and another, £200,000 offered by the defendant to the plaintiff in settlement of a claim, and the sum of £150,000 set aside by the defendant and her co-trustees for payment of this claim. The plaintiff set out that the testator, Sir Joseph Whitworth, was a director of the Electric and International Telegraph Company which was amalgamated in 1855, and the business and plant were purchased by the Government for upwards of £3,000,000, and annexed to the General Post Office under statute 31 and 32 Victoria, by which Act Sir Joseph Whitworth and his co-directors were appointed trustees, and were directed in the first place to pay the debts of the said company out of the moneys awarded to it by Parliament. In 1851 Mr. Allen, when others rested satisfied with 25 miles of cable between Dover and Calais, and thought a 50-mile cable impossible, showed the feasibility of a 70-mile cable, and endeavoured to obtain in his own name a concession from the Belgian Government for a line between England and Ostend, but that privilege was granted to the Submarine Telegraph Company. He was introduced by Mr. Joseph Steer Christopher (now his executor) to a Mr. Adrian Ruyssenaers, a Dutch agent, whom Allen engaged to get in their joint names from the Government the right to lay a submarine cable between England and Holland. On April 5th, 1852, Allen went with Ruyssenaers from Amsterdam to the Hague, and exhibited his telegraph instruments, which he had patented in Holland, to work the proposed line, to the Dutch engineers appointed by the Government. Ruyssenaers then informed Allen that he had applied for the concession in his own name only, instead of their joint names, as he thought it would facilitate his obtaining the privilege, but they were equally to share the profits arising from the concession if granted to Ruyssenaers, who afterwards wrote Allen to have his Dutch patent assigned to them. This was done in conformity with a Royal decree, dated May, 1852. The Minister of the Interior on the following day granted to Ruyssenaers a concession authorising a maximum charge of 8s. 4d. per message of 20 words. Mr. Allen offered Ruyssenaers half whatever he should receive out of the profits derived from working the concession, and the promoters of Allen's United Kingdom Telegraph Company also offered to allow Ruyssenaers a royalty of 1s. on each message, equal to about 12 per cent. on the gross profits, and which would have yielded Ruyssenaers a revenue of £3,000 a year. He was also to have been manager of Allen's Company in Holland. Mr. Allen, being at the time associated with Messrs. Newall, Liddell, and Gordon, of London and Newcastle, was obliged to go to Holyhead to superintend the laying down of a cable to Ireland, and during his absence he was astonished to see a paragraph in the *Times* stating that Ruyssenaers had sold the concession to John Lewis Ricardo, chairman of the Electric Telegraph Company, as trustee for both the International and Electric Companies. That was only a preliminary agreement, and before the final contract between the parties,

the companies had notice of Mr. Allen's interest in the concession. Mr. Allen, in 1856, brought an action against Ruyssenaers and Mr. Ricardo to establish his right to a moiety of the Dutch concession. The jury found a verdict for the plaintiff, they holding that the plaintiff should have one-half of the benefit of the concession, for which concession the Telegraph Company had received from the Government in 1870 £2,000,000. In September, 1857, a supplementary bill was filed against Ruyssenaers and Ricardo, and the Electric and International Telegraph Company were added as defendants, and Ruyssenaers was restrained from receiving any further royalties or moneys in respect of the concession. It was alleged that the defendant's testator and co-directors of the Telegraph Company had fabricated their accounts so as to make it appear no profits had been made out of the concession, whereas, between November, 1854, and June, 1858, a profit of £42,000 was made. The plaintiff claimed under agreements with Mr. Allen and his widow.

Mr. FARWELL said the statement of claim was of such a nature as to entitle his clients to the relief they asked for.

Mr. HIND, who appeared in person, made a long, rambling statement, denying that the action was vexatious and frivolous. Many of the orders which had already been made against him were erroneous and unjust, and in his case against the late Mr. W. H. Smith, instead of getting a million of money he got a week in Her Majesty's Hotel. (Laughter.)

His LORDSHIP made the order asked for. He said it was impossible for the plaintiff to make out any case from the statement of claim. His Lordship also declined to allow the plaintiff to commence any new action against the defendant without the leave of the Court.

NEW PATENTS—1892.

21,108. "Improvements in or relating to the manufacture of aluminium and alloys thereof." C. ALLEN, J. CLARK, and G. W. CLARK. Dated November 21st.

21,136. "Improvements in shade carriers for electric light pillars and brackets." J. TAYLOR. Dated November 21st.

21,147. "Improvements in and relating to electric vehicles for use on roads." C. R. GARRARD and T. W. BLUMFIELD. Dated November 21st.

21,169. "Improvements in regulating apparatus for electric arc lamps." J. DULAIT. Dated November 21st.

21,193. "An improved method of producing zinc from blende by means of electrolysis." G. E. CASSEL and F. A. KJELLIN. Dated November 22nd. (*Complete.*)

21,243. "Improved method of forming junctions between electric light cables and electric lamps." F. W. WEBB and A. M. THOMPSON. Dated November 22nd.

21,268. "Improvements relating to suspension devices, chiefly designed for electric incandescent lamps." S. PORTER and J. R. WHITE. Dated November 22nd. (*Complete.*)

21,273. "Improvements in and relating to electric clocks." M. VAN B. ETHRIDGE. Dated November 22nd. (*Complete.*)

21,292. "An electric alarm for gill drawing frames as used for flax and other fibres." A. MCMEEKIN and J. LOGAN. Dated November 23rd.

21,339. "Improvements in electrical indicators and connections therewith." R. H. KEITLE and C. GRAHAM. Dated November 23rd.

21,348. "Improvements in the treatment of zinc produced by electrolysis." W. WRIGHT and J. B. HAMOND. Dated November 23rd.

21,372. "Improvements in insulators for electric telegraph wires and other electric conductors." B. A. J. ESPEUT, widow and executrix of the late W. B. Espeut. Dated November 23rd.

21,376. "Improvements in electrical resistances." H. EDMUNDS. Dated November 23rd.

21,377. "Improvements in electric conductors." H. EDMUNDS. Dated November 23rd.

21,435. "An electric automatic repeater cut-out." J. FERRIER and J. W. FERRIER. Dated November 24th.

21,480. "Improvements in the means or apparatus for measuring electricity." G. L. ANDERS and W. KOTTGEN. Dated November 25th.

21,506. "Improvements in electrical governors for marine engines." H. A. FERGUSSON. Dated November 25th.

21,530. "Automatic electrical signalling on locomotive engines." J. ATACK. Dated November 25th.

21,533. "Improvements in apparatus for measuring electric potentials and quantities." G. C. FRICKER. Dated November 25th.

21,554. "Improved manufacture of battery plates and employment of ingredients therefor." R. E. DISHER, R. H. C. HALL, and C. CROCKFORD. Dated November 25th.

21,602. "Operating electric meters from a central position in such a way that charge for the current can be varied according to the time of day." W. H. SCOTT. Dated November 26th.

21,613. "Improvements in telephonic transmitters." A. GROPER. Dated November 26th. (*Complete.*)

21,621. "Improvements in and in the manufacture of incandescent lamps." D. V. MITO. Dated November 26th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

The Price of all Specifications (old and new) is now 8d. each.

7,912. "An electric capstan." G. S. GRIMSTON. Dated May 7th. Claim:—An electric capstan driven by reducing gear from a dynamo-electric machine which, with the gear, is enclosed within a water-tight casing under the capstan, substantially as described.

7,937. "Improvements in or relating to electric resistance devices, also applicable for measuring electric currents." C. W. COX. Dated May 8th. Claims:—1. The improvement in electrical resistance devices, which consist in forming them of a tubular resistance coil of platinoid, German silver, iron or the like, through the whole length of which water from a water tank or other source of supply is adapted to circulate, substantially as described, said water conveying only a fraction of the total current flowing, its function being limited to keeping the resistance coil cool. 2. The general combined arrangement and construction of parts forming the improved electric resistance device, substantially as described.

8,151. "Improved means for distributing rotary phase alternating currents to different current-consuming apparatus." SIEMENS BROS. & CO., LTD. (Communicated from abroad by Messrs. Siemens and Halske, of Berlin.) Dated May 12th. Claim:—In electrical installations for the distribution of rotary phase currents, that is to say, of a series of alternating currents of equal period and amplitude, but shifted relatively to each other as regards their phase, the method of providing an additional conductor at the place of consumption, and placing the current consumers that only require a single alternating current in connection with the said supplemental conductor, and with one other of the rotary phase current conductors, such consumers being distributed as evenly as possible in the described manner between the several rotary phase conductors, substantially as described.

8,153. "Improved means for carrying electro-motors on electrically propelled cars or vehicles." SIEMENS BROS. & CO., LTD. (Communicated from abroad by Messrs. Siemens & Halske, of Berlin.) Dated May 12th. According to one arrangement the framing of the electro-motor, which carries the field magnets and armature axis, is supported by springs upon a transverse frame situated below the underframing of the carriage, and fixed to the axle boxes, the bearing springs of the carriage being connected to the transverse frame. The armature, which may either be of the drum or cylinder kind, or of any other suitable construction, is mounted upon a tubular axis, through which the wheel axle passes, the tubular axis being carried in bearings on the motor frame. 5 claims.

8,227. "Improvements in electrodes for electric accumulators." W. P. THOMPSON. (A communication from abroad by H. O. Tudor, of Luxembourg.) Dated May 13th. The object of this improvement is to develop the surface of electrodes by arranging grooves or ridges on a support having itself larger and deeper grooves or projections arranged on both faces. 2 claims.

8,378. "Improvements in or relating to resistances for electric current circuits." H. SOUTH. Dated May 15th. The invention is applied by introducing a resisting portion of the circuit into a suitably closed receptacle containing a certain amount of mercury. The receptacle is fixed, pivoted or otherwise made movable; and the resisting portion of the circuit is preferably so formed or arranged with reference to the mercury, that a small portion thereof is always in contact with the mercury in whatever position the receptacle may be. By relatively moving the receptacle or resistance from that position in which the resistance is only slightly in contact with the mercury to that in which there is the maximum of contact, the resistance is varied from its maximum to its minimum, and lamps in the circuit vary from darkness to full light. 2 claims.

8,450. "Improvements for the connection of electrical conductors to surgical or other instruments." C. S. SNELL. Dated May 16th. To facilitate the connection to the instrument the inventor takes a suitable elastic substance, such as India-rubber of a cylindrical or other suitable shape and of the required size, and to this he fastens a metal strip of any desired form, to which a conductor from the battery or its equivalent is attached. The spring of the substance employed aids in pressing the metal strip against the metal of the instrument. 2 claims.

8,929. "Improvements in ozone apparatus." SIEMENS BROS. & CO., LTD. (Communicated from abroad by Messrs. Siemens and Halske, of Berlin.) Dated May 26th. There is employed according to this invention an electrical arrangement whereby both the electric coatings are situated outside, or on the same side of the dielectric layer. For this purpose a third conducting body must be employed which is situated on the other side of the dielectric layer, and is insulated, having no connection with the coatings. According to one arrangement, the dielectric layer is made flat, and has the two electric coatings on the outer side a certain distance from each other, and separated by an insulating shield fixed to the dielectric layer. At a small distance from the inner side of the dielectric layer is an insulated metal plate. 2 claims.

10,451. "An improvement in posts for carrying electric lights and such like purposes." W. HAYWOOD and C. H. DRIVER. Dated June 19th. The post, preferably of circular section, is made hollow, and throughout most of its length has vertical slots opposite to one another. On a number of horizontal pivots are mounted radius arms, the other ends of which are jointed to bars, one on each side of the post, which can move like the blades of a parallel ruler. Usually they fit into the two slots of the post, in which case the arms are all

contained within the post; but, when one of the pivots is partly turned by a key or otherwise, the two bars and their arms are caused to project outwards from the post on opposite sides, the arms serving as a ladder by which the post can readily be ascended. 1 claim.

18,290. "Improvements in switches for electric lighting." A. P Lundberg. Dated October 24th. The switch consists of an insulating base (china, slate, or any other suitable material), with a square cavity in the centre. To each of the four sides of this cavity is attached a bent (right angle) piece of brass for fixing terminals, and also forming a step to assist in making, together with the square cavity, a quick break of the current when turning the key hereafter described. Moving in a centre of the square cavity is a key of insulating material, to which is attached a metal plate fixed with a centre pin and two split pins; to each of the latter is attached a flexible helical spring which by alternate revolving movements turns the current on or off by making or breaking the connections with the brass pieces mentioned above. The switch key only turns in one direction, and a stop is provided to prevent any movement in the opposite direction. An insulated cover is fitted to the base. 7 claims.

18,348. "Improvements in or connected with the distribution of electricity." T. Parker, J. H. Woodward, and E. S. G. Rees. Dated October 24th. In all systems of electrical distribution with feeders working on to a network of secondary mains, it is usual to employ two independent wires running from the point of the network at which the feeders are connected back to a voltmeter at the regulating apparatus at the central station. According to the present invention, these pilot or voltmeter wires are utilised for working a switch or switches, in the distribution system. 2 claims.

22,352. "Improvements in electric switches." G. E. Painter. Dated December 22nd. The principal object of the invention is to provide a safe and efficient switch which can be put up in an ordinary house, and which will take up no available room, and will not be an unsightly object. The switch is so constructed that it can be let into the wainscotting or framing of doors, and will lie flush therewith, and can be made ornamental, or can be made the same colour as its support, and will be very inconspicuous. 5 claims.

22,782. "Improvements in electric arc lamps." G. C. Fricker. Dated December 30th. Relates to a construction of electric arc lamp, in which the position of the carbons is controlled by a friction block that is arranged to bear against a brake wheel connected with one of the carbons, and is carried by one arm of a loaded lever pivoted to a rod connected with or operated by the core in an ordinary simple or differential solenoid in the lamp circuit, the arrangement being such that when the length of the arc falls below the normal, the friction block is moved by the core, and causes the brake wheel to move the carbons apart, and when the length of arc increases beyond the normal. the pressure between the friction block and brake wheel is lessened, and the carbons allowed to move towards each other by gravity. 2 claims.

CORRESPONDENCE.

High Pressure Steam Generators.—Mr. Thwaite's Reply.

I am honoured with the close scrutiny that your reviewer appears to have given to the remarks in my paper on "High Pressure Steam Generators," read at the Edinburgh meeting of the British Association. It is only by such criticism that one arrives at the exact truth. *Ex parte* statements and opinions are useful enough; but they generally benefit by the frictional influences of critical opinion. Before replying *seriatim* to the observations that your critic has been good enough to make, I shall repeat some of his own positive statements, that are in themselves a quite sufficient justification for the condemnation of the forms of steam generators, known as the ordinary return tube marine—the Lancashire and the Cornish type.

1. Your critic "*deplores* the marine boiler with its nest of tubes directly over the furnaces."

2. He says: "We all know the flat end plate of a boiler is *wrong*, its *form* is *wrong*, its *attachment* to the shell is *faulty*, so *is its attachment* to the *furnaces*, and its *staying* is decidedly *wrong*."

3. Your critic admits "That different portions of a Lancashire boiler are heated to very *different* temperatures is true enough."

I think one is justified in contending that any form of industrial apparatus, having such fundamental disadvantages, should be discarded.

The bane of our constructional art and science is the inherent conservatism of our character, clinging, as it does, to old customs and forms—"Me grandfather used it, and it's goid enough for me," is not an uncommon soliloquy of a northern manufacturer; and whilst France has at last shaken off the conservative elements of her social and political life, we still cling to the social institutions and caste distinctions of the middle ages, and the same conservative tendency manifests itself in our industrial life. The American and French engineers have long ago recognised that the form of the Lancashire and Cornish boiler is bad, and with them the water-tube boiler is accepted, as worthy of almost universal application, and the Lancashire and Cornish boiler is rarely used. This fact alone is an eloquent proof that a new form of steam generator was recognised as being imperatively necessary, and this prompted the birth of the water-tube type, and the American engineers having little of the follow-my-leaderism in their character, frankly accepted the water-tube boiler, as an improvement on the internal flue type.

With all deference to your critic, I contend that this internal single and double flue-steam boiler has still the fundamental disadvantages associated with its form of 1866. It is, of course, admitted that some of the defects have been partially patched up by improvements in the structural details, in the quality of the material, and the finish of the workmanship; but I should like your critic to tell me what the result of the general use of this type would be, in the absence of the lynx-eyed inspection by our boiler insurance companies. I should say, in reply to this, "a record of deaths and disasters."

At my lecture at the Yorkshire College a few years ago, thanks to the courtesy of Mr. Crosland, the walls of the Lecture Hall were filled with photographs of exploded boilers, and scenes showing the ruination to property resulting from a long series of explosions of the Lancashire and Cornish type of steam boilers.

Anyone seeing these photographs, could not have failed to recognise the fact that there was something wrong in an apparatus that had such associated evils and dangers to life and property, and had it not been for these admirable institutions for watching over the safety of boilers, the record of disasters would have been so great as to drive home, as no logic of argument can do, the conviction that the form of this steam-generating apparatus is radically bad.

I do not consider that there should be any compromise in dealing with a feature that your critic admits is wrong.

He gives a direct denial to the statement that the maximum scale accumulation in any Lancashire or Cornish boiler is coincidental with the furnace crown. I have had some experience with both these types of boilers, and hold to the truth of a modification of my statement, *ergo*, the maximum deposition of suspended foreign matter introduced with the feed water is coincidental with the *locale* of the maximum heating surface-evaporating efficiency, and this surface is, of course, the crown of the furnace flue over the fire-grate. The upper layers of the scale shell off after a certain thickness has been accumulated, and fall to the bottom or invert of the shell of boiler, but there is a decided scale *baked* on to the crown plate of flue, and with such a degree of adhesiveness that even the chipping hammer fails sometimes to remove it without part of the metal coming off as well.

I think I could send you a photograph of the interior of a Lancashire boiler that would open your critic's eyes and compel him to confess that a form of steam-generating apparatus in which there are such correlative influences of corrosion and incrustation, tending to weaken and impair the efficiency of the apparatus, deserves to be remodelled altogether.

Your critic's description of the high pressure water tubulous boiler designed by me, is inaccurate.

There are no rivets, in the intense zone of combustion, which is located at the base of the nest of small steam generating tubes.

He says that the strains due to unequal temperatures are reduced to a minimum in modern boilers; if that is so, how are we to account for the grooving of the connecting flanges and angle irons, and the weeping at the lines of attachment —of furnace flues with end plates? At the lecture referred to, I exhibited numerous examples of grooved and corroded flue angle iron and flanges, proving that the dilatent pulsatory effects, set up by irregular and uniform heating influences, *had not been overcome*, and that there is very little doubt but that electrolytic action accompanied the influence

of heat, especially with certain kinds of feed water, and also when the pitting form of corrosion is initiated.

The fact is, boiler constructionalists have not applied the same degree of investigation into the physical, chemical and thermic conditions underlying the generation and transmission of heat for the evaporation of water for steam-power purposes, that has been given to thermo-dynamics applied to the development of the modern steam engine, although in the introduction and design of one of the boilers criticised the author has been associated in its design with an engineer who, more than any other, is responsible for the high-class character of the Continental steam engine practice of to-day.

Your critic has a captious objection to the use of the word zone, applied to heat. I am not sure but that from the time of Sir Humphrey Davy's thermic investigations down to those of Sir Lowthian Bell, all writers on combustion have made use of this expression as appropriate for the indication of the different points or spaces in which varying characters of combustion occur—in fact, there *is* no other English word *at all* available—in describing the chemical reactions involved in the phenomena of flame combustion.

I had the honour of the personal acquaintance of the late Daniel Adamson, and in at least two of my lectures I have paid tribute to the constructive genius, progression, and advanced characteristics of this great Northumbrian-born engineer, but I do not admit that his expansion ring and flanged furnace flue remove the grave and fundamental objections of the form of this Lancashire and Cornish boiler.

Your critic unintentionally compliments the technical literary character of the paper when he says that I appear to have written the paper in approved German. Now, whatever may be said against the German language, I believe it is considered to be more copious, expressive and full for literary, scientific, and technical descriptive work than any other language. As to the translation into English, I must be pardoned for saying that, as an article of mine is considered of sufficient literary merit to appear in a leading monthly, along with an article by a *littérateur* of such acknowledged perfection as is the ex-Premier, I cannot accept your critic's claim to superiority of literary skill.

In contradiction to your critic's referring to the suggested design of vertical boiler, I may say there is not any angle iron round the firebox subjected to intense heat, and as the gas generating part of steam generator is structurally distinctive from the steam pressure part, there would be no danger, even assuming there was an angle iron. Your critic appears to lack discrimination, and, in his endeavour to find fault, imagines defects that do not exist. His objectionable kink in what he calls the firebox is perfectly innocent of any connection with the steam generating part, *per se*.

He does not appear to appreciate the use of the mud-depositing vessel; but his objections are merely opinions, without the substratum of a single argument to support or justify them. He has not sufficiently examined the fuel combustion arrangement, otherwise he would have noticed that it is as different from the ordinary form as the arrangement of the field magnets of an alternator differs from that of a two-pole machine.

In the suggested design of a vertical tubulous high pressure steam generator, the canons of a perfect fuel combustion design are, as far as possible, embodied. The air and gaseous fuel meet under induced pressure in a refractory lined chamber, so that the gas and the air can be mixed in chemically equivalent proportion. I quite admit that ordinary vertical boilers are a smoky lot, owing to their bad combustion arrangements. Many of the remaining remarks of your critic I cordially agree with.

He asks if my steam generator is more accessible than a Lancashire boiler. In reply, it is so designed that by simply turning door handles and opening the side door plates surrounding the nest of small tubes, *every* tube, and *all parts* of the steam generating elements, can be got at. What more can your critic desire? Internal corrosion is influenced by dead water, the result of imperfect circulation.

Your critic probably understands the reactions involved in, and knows the genesis of the corrosion of iron, and will therefore be ready to admit that swiftly-moving currents of water are the best antidote to this insiduous and destructive action.

His remarks respecting the transmission of heat and the production of smoke show that he has a very elementary knowledge of the subject he so airily writes about, otherwise he would well know that once air and gas are properly mixed before, or simultaneous with, ignition—and combustion is initiated in a refractory lined chamber—that however much it is exposed to heat-extracting influences, there will not be smoke produced. Let him place an ordinary water-filled Florence flask on a Bunsen burner, and he will see that, although the *flame* is brought into contact with the thin glass of the flask, almost in direct touch with the water, there will not be a *smoky flame*. To explain exactly why the smoke is produced in vertical bodies would be easy, but it is not pertinent to this subject.*

In conclusion I may say that, although we agree in some and disagree in other statements, I thank your critic for the remarks in the concluding paragraph of his letter, but still think the boiler of the future is the small water-tube type with large steam storage domes.

B. H. Thwaite.

Liverpool, *November 28th*, 1892.

Is the Electric Discharge Oscillatory?

In a leaderette with the above title in your issue of November 25th, you state that "investigators in this field of research have used Ruhmkorff coils to propagate the electrical oscillations. Toëpler, therefore, has endeavoured to study electrical oscillations by the aid of a Toëpler-Holtz machine, and with success." This statement implies that the oscillatory discharge had not previously been obtained with an induction machine. But if you will kindly refer to my paper read before the Physical Society in June, 1888, you will find that I obtained and described the effects with an ordinary Wimshurst machine.

Ernest H. Cook.

December 5th, 1892.

The Dangers of Electric Lighting.

I have been waiting anxiously to see if any reasonable explanation of the occurrence resulting in the death of the fitter, Lang, would be given by his employers, the House-to-House Company, but, as yet, none is forthcoming.

The unfortunate man is now dead beyond recall, but the many workmen daily employed on high-tension circuits have an undoubted right to know how far they are risking their lives, and what precautions are needed, beyond those now in use, to give a reasonable margin of safety in the exercise of their dangerous calling.

This can only be known by sifting such lamentable occurrences as this to the bottom, and all concerned in the control of dangerously high voltage plant should unite in calling upon the House-to-House Company to give a full and free statement as to the actual facts of the disaster, and at present they seem obscure.

Take the evidence of the company's engineer at the inquest, that the insulation of the cable might have been removed by the heat of the man's hand. Can it be imagined that the thick coating of vulcanised rubber in use by the company (to say nothing of the layers of tape and braid) could possibly be affected by the heat of one's hand?

If this is seriously meant, then it could only have occurred at a joint, which had just been covered with rubber *preparatory* to vulcanising; and though it is most improbable that this would have been handled by the man, it is, however, possible.

If the cable covering was chafed, as suggested by a fellow workman, it must have been the work of time, and should have shown in the usual daily tests, as a man might draw a cable with high-class insulation back and forward across the edge of a box all day long without serious injury to the cable.

Many other points might be raised, but until the actual facts are disclosed speculation is idle.

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* See "Gaseous Fuel," by B. H. Thwaite. Whittaker, London.

As to the use of gloves, surely no practical man would say that rubber gloves are used in making 1 per cent. of high-tension joints.

Say that the current is on, would a jointer remove the insulation with an ordinary jointer's knife and feel he was secure in wearing a thin rubber glove? Would he use his pliers and make, bind and solder, the joint without risk—could he properly insulate the joint with the rubber solution, rubber strips, vulcanising rubber, &c., while wearing gloves? Theoretically he might, but practically he does not.

How long would the gloves last at this work, or even in drawing-in cable?

I fancy the contract for the supply of gloves under these circumstances would be expensive.

The explanation given won't bear examination, and in the interests of public safety, and for the credit of high-tension systems, we have a right to expect something better from those claiming to be pioneers in such undertakings.

"2,000 Volts."

Re Fire at London Stereoscopic Company's, Regent Street.

Mr. Musgrave Heaphy asks us to publish the following, which is a copy of a letter he has addressed to the editor of a contemporary:

"My attention has been called to a letter you publish in your last issue, signed by J. D. F. Andrews.

"The statement he makes therein, that I examined and passed the electrical installation at the London Stereoscopic Company's premises, contains not a single word of truth. I know nothing whatever about the installation, nor were any of the insurances effected in the Phœnix Fire Office.

"With regard to Scott's Oyster Rooms, I never saw the installation, nor was I even aware that the electric light was in the premises. Neither was the Phœnix Fire Office aware that there was any electrical installation, the work having been placed up some years ago, when the premises were insured in another fire office. As to whether there is the slightest justification in laying the charge of the fire to electricity, I leave those concerned to say, if they think it worth their while.

"I must request you to publish this letter, as the false and misleading manner in which Mr. J. D. F. Andrews has made use of my name, makes me depart from my rule, of passing unheeded, erroneous or unjust statements in print with regard to myself or works.

"Musgrave Heaphy."

"*December 6th*, 1892.

Price of Electric Supply.

In reference to Dr. Hopkinson's proposed method of charging for electricity in Manchester, I believe I may claim to have been the first to suggest a scale of charges depending on the maximum current demanded by a consumer.

The schedule of prices for the electric lighting license granted to the Liverpool Electric Supply Company in 1888, contained a sliding scale of charges per quarter which may be shortly expressed as follows:—

1. For any number of units up to 100 times the number of units per hour of maximum demanded supply, 1s. per unit.
2. For any further quantity up to 100 times the maximum demanded supply per hour, 8d. per unit.
3. For any further quantity, 4d. per unit.

For example, a consumer demanding a maximum supply of three units per hour, and having used 1,100 units in a quarter, would be charged the following rates.

Three hundred units at 1s., 300 units at 8d., and the balance of 500 units at 4d.

It was found, however, that the consumers had some difficulty in understanding the scale, being accustomed to the sweet simplicity of the uniform rate charged by the local gas company, and that dissatisfaction was always expressed by consumers who used their lamps only a small number of hours, and therefore never reached the lower rates.

All sliding charges, based on the maximum demanded supply, have the serious disadvantage of limiting the number of lamps fitted up by a consumer to the smallest number he can possibly do with, thus preventing the adoption of the light in positions where the lamps are only occasionally required.

A sliding scale is also an obstacle to the introduction of the light in buildings not often used, and especially churches, which are valuable customers to a supply company, on account of only requiring a supply on Sundays, when the central station load is at a minimum.

Four years' trial of the above method of charging in Liverpool proved that its disadvantages were greater than its advantages, and consequently, in the Liverpool Electric Lighting Order of 1892, the sliding scale was repealed, and a uniform rate of charge substituted.

The present price charged in Liverpool is 7½d per unit, or about double the price of gas, and with a rapidly-increasing demand for electric light, and the more efficient and cheaper incandescent lamps that may be expected when the present oppressive monopoly in lamps comes to an end next year, the day is not far distant when the electric light will, in addition to its many advantages, be light for light as cheap as gas.

A uniform rate has been found to answer well in the case of the greater number of gas and water companies, and is equally suitable for electric supply companies when the circumstances permit of a reasonably low price being charged.

A. Bromley Holmes.

December 5th, 1892.

Varley Testimonial.

We shall be glad if you will allow us the opportunity of calling the attention of your readers who are interested in the above to the fact that, although we have received encouraging responses and subscriptions from some of those we expected to aid us, yet the response, as a whole has, up to the present, been disappointing, more especially on the side of the manufacturing community. We are sure that it will be found, in most cases, that this is due to our circular letter of appeal having been overlooked owing to its being sent out during the season when a good many members of the electrical profession were away on their holidays.

The object of this letter is to remind them, and all others who have benefited by the undoubted impulse which Varley's inventions gave to electrical engineering, to send in, without further delay, their subscriptions, according to their means, to Mr. A. Stroh, 98, Haverstock Hill, N.W., endorsing subscriptions to "Varley testimonial fund."

A. Stroh, *Hon. Treasurer.*
R. E. Crompton, *Hon. Secretary.*

London, W., *December 5th*, 1892.

Country House Lighting.

We quite agree with your correspondent, Mr. Adrian Collins, that there is nothing startlingly novel in the distribution method of wiring Mr. Hanbury's house at Poles, as we ourselves have for some time past employed this method exclusively for both town and country work. As to the net cost, our experience differs from that of Mr. Collins, for we find it comes out higher than for the methods usually employed.

The Electrical Installation Company, Limited.

December 6th, 1892.